Marconi
Instruments

2960

RADIO TEST SYSTEM
Option 30 for TACS

Operating Manual
Supplement 30

Operating Manual

H 52960-900R
Volume 1
Supplement 30

PROVISIONAL

RADIO TEST SYSTEM

2960

Option 30

for TACS

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ASSOCIATED PUBLICATIONS

Operating Manual (H 52960-900R Vol. 1)	Part no. 46881-900L
Operating Manual Supplements	(See in the Preface.)
Programming Manual (H 52960-900R Vol. 1A)	(To be published later.)
Programming Manual Supplements	(See in the Programming Manual.) (To be published later.)
Service Manual (H 52960-900R Vol. 2)	(To be published later.)

PREFACE

The Radio Test System 2960 consists of a Radio Communications Test Set 2955 with a Multi-system Adapter. The Adapter includes software for one or more systems. The Adapter can accept up to six co-resident options. Five options are currently available as below.

Features which are common to all of the systems are described in the Operating Manual.

To describe features in which there are differences between systems, there is an Operating Manual Supplement for each system. The Supplement has the same number as the option as follows:-

Option no.	System	Supplement	
		No.	Part no.
10	NMT	10	46881-901J
20	AMPS	20	46881-902F
30	TACS	30	46881-903G
40	Radiocomm 2000	40	46881-904V
50	Band III	50	46881-905S

This Supplement is for Option 30 (TACS).

AMENDMENT STATUS

Each page bears the date of the original issue or the date and number of the latest amendment. Any changes subsequent to the latest amendment are included on Manual Change sheets coded C1, C2 etc.

WARNINGS AND CAUTIONS

See the common Operating Manual.

Chapter 1

PERFORMANCE DATA

General TACS system information

Number of channels

TACS:	600.
E-TACS:	1320.

Allocation of channels

1 to 300:	System A (Racal-Vodaphone).
301 to 600:	System B (TSCR-Cellnet).
601 to 1000:	Reserved.
1001 to 1328:	Not defined.
1329 to 2047 and 0:	E-TACS.

Dedicated control channels

23 to 43:	System A (Racal-Vodaphone).
323 to 343:	System B (TSCR-Cellnet).

Mobile transmit frequency channel 1:	890.0125 MHz.
Mobile receive frequency channel 1:	935.0125 MHz.
Duplex offset:	45 MHz.
Channel spacing:	25 kHz.
Voice deviation FM:	±9.5 kHz maximum.
Data deviation:	±6.4 kHz ±10%.
Data type:	FSK Manchester encoded, BCH parity.
Data rate:	8 kbit/s ±1 bit/s.
Supervisory audio tone frequencies:	5.970 kHz, 6.000 kHz and 6.030 kHz.
SAT deviation:	1.7 kHz ±10%.
Signalling tone frequency:	8 kHz ±1 Hz.
Signalling tone deviation:	6.4 kHz ±10%.
Signalling tone duration:	50 ms, 400 ms or 1.8 s ±10%.
Other tones:	DTMF sent in conversation from mobile by pressing key pad.

Noise measurement
filtration: CCITT psophometric.

Mobile transmit power

Class 1:	Power level 0	7.08 W.
	Power level 1	1.12 W.
	Power level 2	447 mW.
	Power level 3	178 mW.
	Power level 4	70.8 mW.
	Power level 5	28.2 mW.
	Power level 6	11.2 mW.
	Power level 7	4.47 mW.
	SCM	XX00.
Class 2:	Power level 0	2.82 W.
	Power level 1	1.12 W.
	Power level 2	447 mW.
	Power level 3	178 mW.
	Power level 4	70.8 mW.
	Power level 5	28.2 mW.
	Power level 6	11.2 mW.
	Power level 7	4.47 mW.
	SCM	XX01.
Class 3:	Power level 0	1.12 W.
	Power level 1	1.12 W.
	Power level 2	447 mW.
	Power level 3	178 mW.
	Power level 4	70.8 mW.
	Power level 5	28.2 mW.
	Power level 6	11.2 mW.
	Power level 7	4.47 mW.
	SCM	XX10.
Class 4:	Power level 0	447 mW.
	Power level 1	447 mW.
	Power level 2	447 mW.
	Power level 3	178 mW.
	Power level 4	70.8 mW.
	Power level 5	28.2 mW.
	Power level 6	11.2 mW.
	Power level 7	4.47 mW.
	SCM	XX11.

System parameter settings

Area identity:	5 digits (decimal). Default 03592.
Control channel:	0 to 2047. Default 323.
First voice channel:	0 to 2047. Default 1.
Last voice channel:	0 to 2047. Default 600.
Handoff increment:	1 to 2047. Default 300.

SAT frequency:	5.970, 6.000 or 6.030 kHz. Default 5.970 kHz.
Digital colour code (DCC):	0, 1, 2 or 3. Default 0.

Mobile parameter settings

Mobile number (MIN):	Format XXX-X-XXXXXX. Default 000-0-000000.
Charge rate:	0 to 1023. Default 0.

Display format settings

Display format:	SUMMARY or FULL. Default SUMMARY.
Pause:	ALWAYS, MANUAL ONLY or ON FAILURE. Default MANUAL ONLY.
Number format:	HEXADECIMAL, DECIMAL, OCTAL or STANDARD (STANDARD is as the BABT format). Default STANDARD.

Test sequence setting

Test sequence:	BRIEF TESTING, COMPREHENSIVE TESTING, CALL PROCESSING ONLY or CALL AND RF TESTING. Default BRIEF TESTING.
DTMF:	ENABLED or DISABLED. Default DISABLED.
Hook flash:	ENABLED or DISABLED. Default DISABLED.

Test modes

Go/no-go test:	Displays summary test lines.
Full auto test:	Split screen displays duplex radio parameters and summary test line.
Manual test:	Permits manual selection of various data modes and alteration of signalling parameters. For use in conjunction with 2955 mode.
Test pause facility:	Pause on manual only, pause on test failure or pause always.

Test sequences

Call processing only:

Registration, Test routine no. 20.
Call cell from mobile, Test routine no. 22.
(Repeated if failed first time.)

DTMF tones, Test routine no. 30 (if enabled).
Hook flash, Test routine no. 31 (if enabled).
Clear from mobile, Test routine no. 27.
Call mobile from cell, Test routine no. 23.
(Repeated if failed first time.)
Automatic handoff, Test routine no. 24.
Clear down from cell, Test routine no. 26.
Print summary.

Call and RF testing:

Registration, Test routine no. 20.
Call cell from mobile, Test routine no. 22.
(Repeated if failed first time.)
DTMF tones, Test routine no. 30 (if enabled).
Hook flash, Test routine no. 31 (if enabled).
Clear from mobile, Test routine no. 27.
Call mobile from cell, Test routine no. 23.
(Repeated if failed first time.)

The following are repeated as many times as necessary to satisfy the channel settings in the system parameters menu (i.e. from the first voice channel to the last voice channel incrementing by the handoff increment) -

Handoff, Test routine no. 23.
Skip on to try next channel if failed.
TX RF power, Test routine no. 28 (power level 0).
SAT transponding, Test routine no. 25.

After the above have been repeated as necessary -

Clear down from cell, Test routine no. 26.
Print summary.

This sequence can be used as a quick test when only an RF connection can be made.

Brief testing:

Registration, Test routine no. 20.
Call cell from mobile, Test routine no. 22.
(Repeated if failed first time.)
DTMF tones, Test routine no. 30 (if enabled).
Hook flash, Test routine no. 31 (if enabled).
Clear from mobile, Test routine no. 27.
Call mobile from cell, Test routine no. 23.
(Repeated if failed first time.)

The following are repeated three times from the first voice channel to the last voice channel incrementing by the handoff increment -

Handoff, Test routine no. 23.
Skip on to try next channel if failed.
SAT transponding, Test routine no. 25.
SAT frequency, Test routine no. 25.
TX RF power, Test routine no. 28 (all levels).
TX RF frequency, Test routine no. 2.
TX AF noise, Test routine no. 3.
TX limiting, Test routine no. 4.
RX distortion, Test routine no. 6.
RX sensitivity, Test routine no. 7.

After the above have been repeated three times -
Print results.
Clear down from cell, Test routine no. 26.
Print summary.
(The results are printed in a tabular form annotated LOW CHANNEL, MID CHANNEL and HIGH CHANNEL. Three channels are always tested, regardless of the handoff increment, etc.)

Comprehensive testing:

Registration, Test routine no. 20.
Call cell from mobile, Test routine no. 22.
(Repeated if failed first time.)
DTMF tones, Test routine no. 30 (if enabled).
Hook flash, Test routine no. 31 (if enabled).
Clear from mobile, Test routine no. 27.
Call mobile from cell, Test routine no. 23.
(Repeated if failed first time.)
Data performance, Test routine no. 29.
The following are repeated as many times as satisfies the channel settings in the systems parameters menu (i.e. from the first voice channel to the last voice channel incrementing by the handoff increment).
Handoff, Test routine no. 23.
Skip on to end if failed.
SAT transponding, Test routine no. 25.
SAT frequency, Test routine no. 25.
TX RF power, Test routine no. 28 (power level 7).
DC power, Test routine no. 9.
TX RF power, Test routine no. 28 (power level 6).
DC power, Test routine no. 9.
TX RF power, Test routine no. 28 (power level 5).
DC power, Test routine no. 9.
TX RF power, Test routine no. 28 (power level 4).
DC power, Test routine no. 9.
TX RF power, Test routine no. 28 (power level 3).
DC power, Test routine no. 9.
TX RF power, Test routine no. 28 (power level 2).
DC power, Test routine no. 9.
TX RF power, Test routine no. 28 (power level 1).
DC power, Test routine no. 9.
TX RF power, Test routine no. 28 (power level 0).
DC power, Test routine no. 9.
TX RF frequency, Test routine no. 2.
TX AF distortion, Test routine no. 3.
TX residual noise, Test routine no. 3.
TX limiting, Test routine no. 4.
TX compression, Test routine no. 5.
RX distortion, Test routine no. 6.
RX sensitivity, Test routine no. 7.
RX expansion, test routine no. 8.
After the above have been repeated as necessary -
Clear down from cell, Test routine no. 26.
DC power, Test routine no. 9.
Print summary.

Test routine no. 1

Transmitter RF power

Upper limit:	6.5 dBW.
Lower limit:	0.5 dBW.

Test routine no. 2

Transmitter RF frequency

Reference frequency:	As currently selected channel.
Maximum error:	2.3 kHz.

Test routine no. 3

Transmitter AF distortion and SINAD

Filtration:	300 Hz to 3.4 kHz.
Lower limit:	26 dB.
Standard modulation level:	2.3 kHz

Test routine no. 4

Transmitter modulation limiting

Upper limit:	9.5 kHz.
Overload factor:	20 dB.
Standard modulation level:	5.7 kHz.

Test routine no. 5

Transmitter modulation compression

Compression ratio:	2.
Maximum error:	10%.
Standard modulation level:	2.3 kHz.

Test routine no. 6

Receiver AF distortion and SINAD

Filtration:	300 Hz to 3.4 kHz.
Lower limit:	24 dB.
RF generator level:	-80 dBm.
Standard modulation level:	2.3 kHz.

Test routine no. 7

Receiver sensitivity

Filtration:	Psophometric CCITT.
Upper RF level limit:	-113 dBm.
Reference SINAD:	20 dB.
Standard modulation level:	2.3 kHz.

Test routine no. 8

RX demodulation expansion

Expansion ratio:	2 : 1.
Maximum error:	10%.
Standard modulation level:	2.3 kHz.

Test routine no. 9

DC power consumption

Upper limit:	100 W.
Lower limit:	1 W.

Test routines nos. 10 to 19 (Not implemented.)

Test routine no. 20

Registration

RF generator level:	-40 dBm.

Test routine no. 21

Call from cell to mobile

RF generator level:	-40 dBm.

Test routine no. 22

Call from mobile to cell

RF generator level:	-40 dBm.

Test routine no. 23

Handoff

SAT colour code	Rotated with each handoff (i.e. 0 to 1, 1 to 2 and 2 to 0).

Test routine no. 24

Automatic handoff

SAT colour code	Rotated with each handoff (i.e. 0 to 1, 1 to 2 and 2 to 0).

Test routine no. 25

SAT transponding

Reference deviation:	1.7 kHz.
Reference frequency:	As SAT colour code (i.e. 0 = 5.970 kHz, 1 = 6.000 kHz and 2 = 6.030 kHz).
Maximum error:	20%.

Test routine no. 26

Clearing down from cell

Test routine no. 27

Clearing down from mobile

Test routine no. 28

Mobile TX power

Power level:	0 to 7.
Upper limit:	+2 dB.
Lower limit:	-4 dB.

Test routine no. 29

Data performance

Lower limit:	95% of audit orders confirmed by mobile.
RF generator level:	-113 dBm.

Test routine no. 30

DTMF tones

Test routine no. 31

Hook flash

Test routine no. 32

Data deviation

Nominal deviation:	6.4 kHz.
Maximum error:	10%.

Test routine no. 33

ST deviation

Nominal deviation:	6.4 kHz.
Maximum error:	10%.

Test routine no. 34

ST duration

Nominal duration:	Dependent on preceding tests. 50 ms for Handoff. 400 ms for Hook flash. 1.8 s for a Clear down.
Maximum error:	10%.

Manual operation

Channel selection:	0 to 2047. (Channels 1001 to 1328 are mapped below channel 1329.)
SAT frequency setting:	3 to 8 kHz. (Hardware resolution 5 Hz.)
SAT level:	0 to 2.5 kHz. (Hardware resolution nominally 12 Hz.)
Data level:	0 to 8 kHz. (Hardware resolution nominally 40 Hz.)
Non-conversation operating modes:	DATA OFF (SAT measurement enabled), DOTTING (4 kHz), SIGNAL TONE (8 kHz), FCC, REGISTRATION, PAGE MOBILE and PLACE CALL.
Conversation operating modes:	CONVERSATION, HANDOFF, POWER LEVEL, CHARGE RATE and CLEAR DOWN.
Audio paths for use with 2955 mode:	RX (AF input), RX x20 (AF input amplified with a gain of 20) and TX (demodulated signal from Adapter).
SAT measurement:	SAT deviation is measured while SAT is being displayed. Otherwise, the reading is frozen. Update rate is every 6 seconds if DC voltage is >1 V. Otherwise, it is every 2 seconds.
ST indication:	When a signalling tone is being received, ST is displayed.
DTMF tones:	Up to 10 tones are displayed. More than 10 causes the display to rotate.
DC power:	DC voltage, current and calculated power indicated if >1 V.

Chapter 3-0

INTRODUCTION TO OPERATION

CHAPTERS

As the 2960 is so versatile, operation is covered in three chapters as follows:-

(a) Chapter 3-0. This introductory chapter.

(b) Chapter 3-1. This covers local operation by using the controls on the 2955 and on the Adapter.

(c) Chapter 3-2. This covers remote control using the GPIB interface port or the RS-232 serial interface port.

The Programming Manual covers programming for remote control and to enable the user to define his own test sequences and to define parameters in test routines for local control.

INTERCONNECTIONS

Start by connecting the radio under test to the 2960 as described on page 3-1-3.

STARTING

When you switch on, the normal **RECEIVER TEST** display (Fig. 3-2) appears. Press the CRTS key on the Adapter. Initializing and self-testing take place as shown on the display (Fig. 3-3). When this is completed, the main top level menu (Fig. 3-4) appears.

If your instrument is fitted only with the TACS system option or if TACS is shown in the display title, press the FULL AUTO TEST soft key. Otherwise, select the system as described on page 3-1-8.

When you have pressed the FULL AUTO TEST key, the FULL AUTO TEST intermediate display (Fig. 3-6) appears. If the parameters which are shown on this display exactly match the needs of your radio, you can carry on by pressing the START TEST key.

These top level menus and options are summarized in Table 3-2.

CHANGING FORMAT

If the system parameters do not match the radio under test, press the CHANGE FORMAT soft key. The **CHANGE FORMAT MENU** (Fig. 3-7) appears. This leads you to a series of menus so that you can alter any of these parameters. These menus are summarized in Table 3-2.

For full details, see pages 3-1-9 to 3-1-20.

TABLE 3-2 TOP LEVEL MENUS AND OPTIONS FOR TACS

Menu	Option	Menu	Option	Page
Main				3-1-7
	GO/NO-GO TEST			3-1-21
	FULL AUTO TEST	Intermediate		3-1-9
			START TEST	3-1-22
			CHANGE FORMAT	3-1-9
	MANUAL TEST			3-1-27
	SELECT SYSTEM			3-1-8

FULL AUTO TEST

When you start this test, the 2960 automatically performs the test routines which make up a test sequence. The test sequence is built-in or user-defined and is selected from the **CHANGE FORMAT MENU**.

For full details, see pages 3-1-22 and 3-1-23.

GO/NO-GO TEST

This is similar to the FULL AUTO TEST but it provides only summarized results for each test routine.

For full details, see page 3-1-21.

MANUAL TEST

When you select this mode, you are given the choice of a number of manual tests which can be made. This is useful for trouble-shooting and fault-finding.

For full details, see pages 3-1-27 to 3-1-29.

TEST SEQUENCES

The FULL AUTO TEST and the GO/NO-GO TEST consist of a number of test routines which are combined into built-in or user-defined test sequences.

For full details, see pages 3-1-30 to 3-1-32.

TEST ROUTINES

Each test routine is carried out automatically. There is a choice of eighteen test routines which are combined in the four built-in test sequences and which are available for user-defined test sequences.

For full details, see pages 3-1-33 to 3-1-44.

TABLE 3-3 CHANGE FORMAT MENUS FOR TACS

Menu	Option	Page
SYSTEM PARAMETERS		3-1-10
	AREA ID	3-1-11
	CONTROL CHANNEL	3-1-11
	VOICE CHANNEL	3-1-11
	HANDOFF INCREMENT	3-1-11
	SAT FREQUENCY	3-1-11
	DCC	3-1-11
MOBILE PARAMETERS		3-1-12
	MOBILE NUMBER	3-1-12
	CHARGE RATE	3-1-12
DISPLAY FORMAT		3-1-12
	DISPLAY FORMAT	3-1-13
	PAUSE	3-1-13
	NUMBER FORMAT	3-1-13
TEST SEQUENCE		3-1-14
	BRIEF TESTING	3-1-31
	COMPREHENSIVE TESTING	3-1-32
	CALL PROCESSING ONLY	3-1-30
	CALL AND RF TESTING	3-1-30
	User-defined test sequence	
	DTMF	3-1-14
	HOOK FLASH	3-1-14
PRINTER		3-1-15
	PRINTER PORT	3-1-15
	PRINT	3-1-15
	TERMINATE	3-1-15
INTERFACE		3-1-16
	BAUD RATE	3-1-17
	LENGTH/PARITY	3-1-17
	STOP BITS	3-1-17
	GPIB ADDRESS	3-1-17
MISCELLANEOUS		3-1-17
	DE-MOD SOURCE	3-1-18
	DISC STEP RATE	3-1-18
	PRINTER PORT COMMAND	3-1-18

Chapter 3-1

OPERATION

OPERATING SUMMARY

The 2960 is used to test a cellular or trunked mobile radio by simulating the functions of a cell base station.

Any one of the following test modes can be used:-

(a) GO/NO-GO TEST. See page 3-1-21.
(b) FULL AUTO TEST. See page 3-1-22.
(c) MANUAL TEST. See page 3-1-27.

For the FULL AUTO TEST, the display is in one of the following forms:-

(a) SUMMARY DISPLAY. See page 3-1-21.
(b) FULL DISPLAY. See page 3-1-22.

These are selectable from a menu. With FULL DISPLAY, the top half of the display is the 2955's normal **DUPLEX** test display. The bottom half shows the title, the status and the result of the current test routine. SUMMARY DISPLAY is always selected for the GO/NO-GO TEST mode and it can be selected for the FULL AUTO TEST mode. The SUMMARY DISPLAY shows only the title, the status and the result of the current test routine. Passed test routines scroll up and off the screen; failed test routines remain at the top of the screen.

The 2960 contains four built-in test sequences as follows:-

(a) CALL PROCESSING ONLY. See page 3-1-30.
(b) CALL AND RF TESTING. See page 3-1-30.
(c) BRIEF TESTING. See page 3-1-31.
(d) COMPREHENSIVE TESTING. See page 3-1-32.

Each of the test sequences consists of a number of test routines. Eighteen test routines are available. There are two groups - non-system specific test routines as shown in Table 3-4 and system specific test routines as shown in Table 3-5. The non-system specific test routines are applicable to any cellular or trunked radio system but these system specific test routines are applicable only to the TACS system.

TABLE 3-4 NON-SYSTEM SPECIFIC TEST ROUTINES

Test routine no.	Parameter
1	Transmitter RF power.
2	Transmitter RF frequency.
3	Transmitter AF distortion and SINAD.
4	Transmitter modulation limiting.
5	Transmitter modulation compression.
6	Receiver AF distortion and SINAD.
7	Receiver sensitivity.
8	Receiver demodulation expansion.
9	DC power consumption.
10 to 19	(Not implemented.)

TABLE 3-5 SYSTEM SPECIFIC TEST ROUTINES (TACS)

Test routine no.	Parameter
20	Registration.
21	Call from cell to mobile.
22	Call from mobile to cell.
23	Handoff.
24	Automatic handoff.
25	SAT transponding.
26	Clearing down from cell.
27	Clearing down from mobile.
28	Mobile TX power.
29	Data performance.
30	DTMF tones.
31	Hook flash.
32	Data deviation.
33	ST deviation.
34	ST duration.
35 to 39	(Not implemented.)

The menus which allow the user to define all the parameters are accessed by selecting FULL AUTO TEST on the top level menu. The succeeding menu gives the option CHANGE FORMAT. Pressing this soft key brings up two pages of **CHANGE FORMAT MENU** which enables the user to change parameters from the following:-

(a) **SYSTEM PARAMETERS MENU.**
(b) **MOBILE PARAMETERS MENU.**
(c) **DISPLAY FORMAT MENU.**
(d) **TEST SEQUENCE MENU.**
(e) **PRINTER MENU.**
(f) **INTERFACE MENU.**
(g) **MISCELLANEOUS MENU.**

Six memories are available for storing six full sets of parameters.

A printer can be connected to the GPIB port (with the printer in listen-only mode), the RS-232 port (serial printer) or to the parallel control port (parallel printer). The printer can print either a summary of the test routines performed or only the passes or failures as they occur.

A disc drive can be connected to the Adapter using the connector on the right-hand side. The drive has to be compatible with the Shugart S.400 interface and may be 3.5 or 5.25 inch, 40 or 80 track. Discs can be single-sided or double-sided although only 40 track on one side are used.

During the FULL AUTO TEST mode, the test sequence can be halted by use of the PAUSE key. A menu is provided to allow the user to define when the selected test sequence should halt. See page 3-1-13. Options available are as follows:-

(a) Pause after each test routine.
(b) Pause by manual use of the PAUSE key.
(c) Pause when failure occurs in a test routine.

INTERCONNECTIONS

For audio tests, it may be necessary for the user to construct an interface unit. The unit has to be compatible with the radio under test and with the 2955's AF output and the Adapter's AF input requirements. The unit is typically connected between the radio's handset and its transceiver unit to provide suitable unbalanced connections from the microphone to the 2955's AF GEN OUTPUT socket and the earphone to the Adapter's AF INPUT socket.

Bearing in mind that the radio and test interface connections are likely to vary between manufacturers, connect the 2960 to the radio under test, as shown in Fig. 3-1, as follows:-

(1) Connect the 2955's RF IN/OUT N socket to the transceiver's antenna connector. This is required for all tests.

(2) Connect the 2955's AF GEN OUTPUT socket and the Adapter's AF INPUT socket to the audio test interface unit. This is required for the BRIEF TESTING and the COMPREHENSIVE TESTING sequences.

(3) Connect the radio's DC power input leads to its DC supply using the Adapter's DC in/out connectors - the radio to the right-hand pair and the supply to the left-hand pair. These connections are only required for measuring the radio's input power in the COMPREHENSIVE TESTING sequence or in the MANUAL TEST mode. Otherwise, the radio can be connected directly to its power supply.

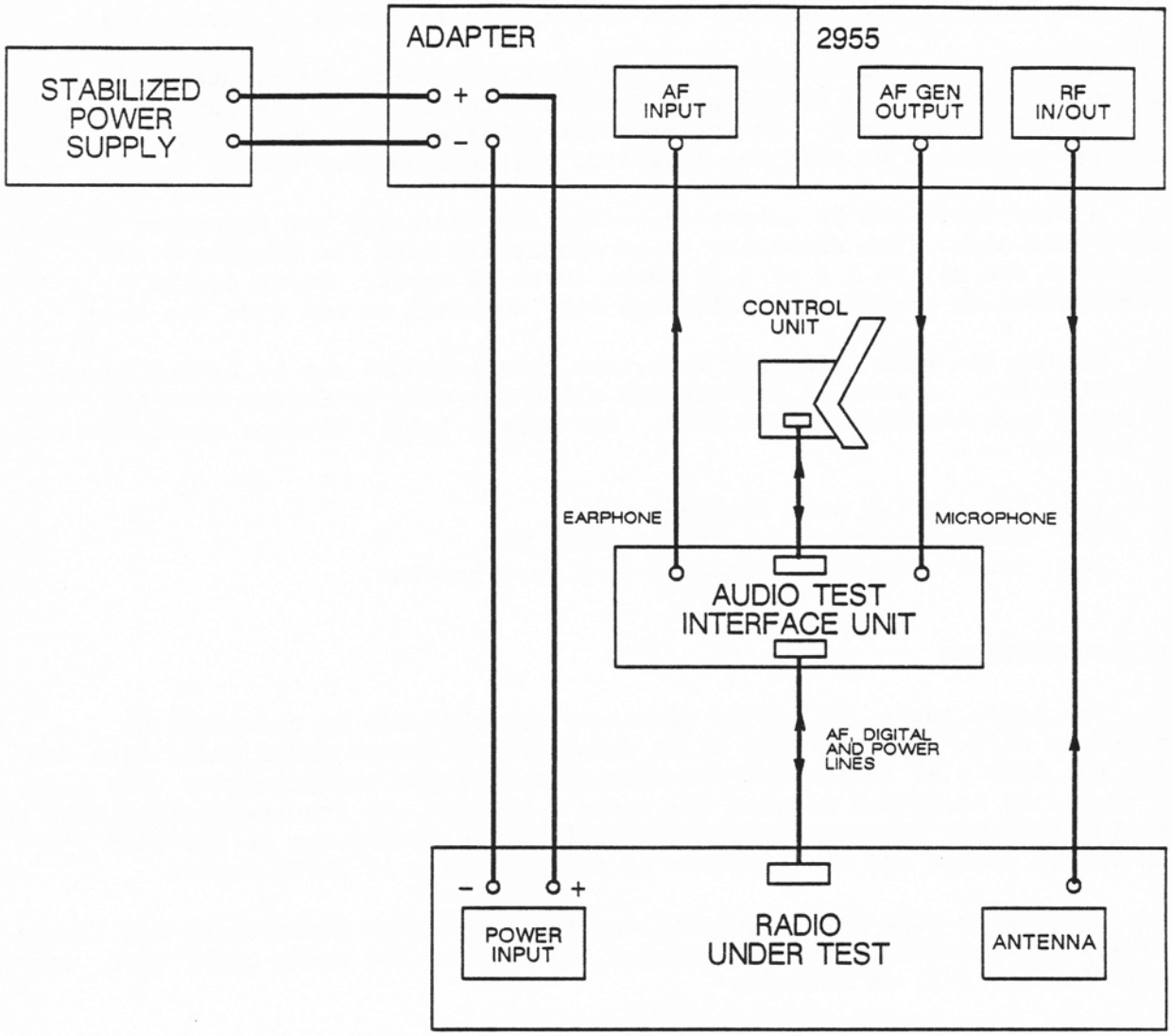


Fig. 3-1 Interconnections

CRTS MODE

Proceed as follows:-

(1) Switch on both the 2955 and the Adapter. (There is no particular order of switching on). All 4 LEDs on the Adapter light and then go out after a pause. The **RECEIVER TEST** display appears on the screen as shown in Fig. 3-2. The LED lights above the 2955 key on the front panel of the Adapter. If one or more LEDs flash, this indicates a fault condition. (See 'Conditions indicated by LEDs' below).

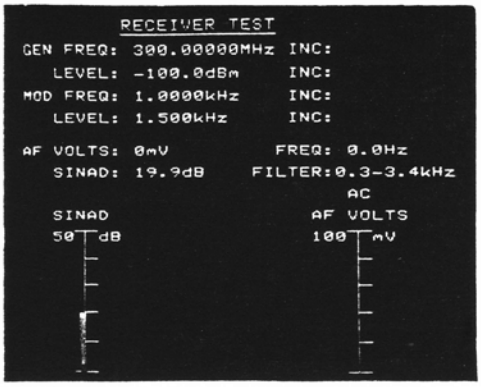


Fig. 3-2 Display following switch-on

(2) Press the CRTS key. The display changes to **TACS CELLULAR RADIO TEST SYSTEM** as shown in in Fig. 3-3. The 2960 goes through an initializing procedure and then a series of self tests. Each self test appears on the screen and, if passed, is replaced by the next one. When a failure occurs, the CONTINUE key appears together with an appropriate message. To retain a test and subsequent tests on the screen, press the TX key during that test. This effect is cancelled when the TX key is pressed again. At the end of the self tests, part numbers for the Adapter's motherboard and personality board software and the hardware serial number are given. During the self tests, software version numbers are displayed for the motherboard, the personality board and the 2955. When the self tests are successfully completed, the main top level menu appears on the screen. This menu is the starting point for selecting the various test functions.

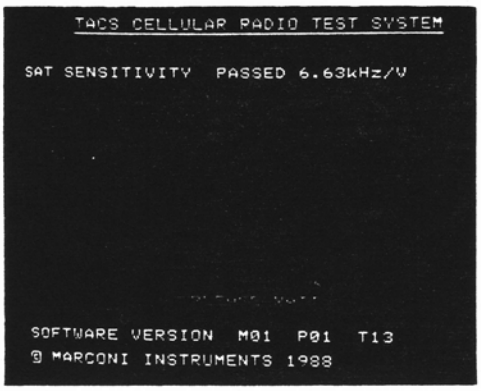

TACS CELLULAR RADIO TEST SYSTEM
SAT SENSITIVITY PASSED 6.63kHz/V
SOFTWARE VERSION M01 P01 T13
© MARCONI INSTRUMENTS 1988

Fig. 3-3 Display following CRTS mode selection

Note...

If the message MEMORY CORRUPTED appears, it means that the settings used when the 2960 was last switched on have been lost. They are replaced by the default settings.

Conditions indicated by LEDs

When one or more of the LEDs on the Adapter flashes, it indicates a failure to successfully enter the required mode or that there is an error condition. The various conditions are summarized in Table 3-6.

TABLE 3-6 LED INDICATIONS

LEDs	Condition	Meaning
All on	At power on	Test function - LEDs should go out after a pause
All flashing	At power on	Volatile RAM failure - instrument cannot continue
2955 flashing	At power on	2955 is not responding on private GPIB - instrument cannot continue until fault is rectified
CRTS flashing	At power on	ROM checksum failure - instrument continues when an Adapter key is pressed if it can
	After power on	CRTS has been selected but 2955 is not responding or is set to talk only mode
DISC flashing	At power on	Non-volatile RAM checksum failure - instrument continues and resets memory to default data when an Adapter key is pressed
	After power on	DISC has been selected but the 2955 is not responding or is set to talk only mode
PSOPH flashing	At power on	System option ROM checksum failure - instrument continues when an Adapter key is pressed if it can

Self test failure messages

When a failure occurs during self testing, the appropriate bit in an error byte is set and a message under the relevant heading is displayed. In remote operation, the error byte may be read when self testing is complete by sending RD55 in immediate mode (but before entering DISC mode which uses the same byte for disc errors). Messages displayed on the screen are shown in Table 3-7 together with the relevant bit which is set in the error byte and the reason for the failure.

TABLE 3-7 SELF TEST FAILURE MESSAGES

Message	Error byte	Meaning
SAT:UNLOCKED	Bit 0 = 1	>±10 Hz of nominal centre of frequency
SAT:LEVEL	Bit 1 = 1	>20% of FS or >5% of nominal
SAT:DETECTOR	Bit 2 = 1	Not detected off or on
DTMF	Bit 3 = 1	Error in 16 tones
DATA:REF CLOCK	Bit 4 = 1	>±10 Hz of nominal centre frequency
DATA:LEVEL	Bit 5 = 1	>±20% of FS or >±10% of nominal
DATA:MODEM	Bit 7 = 1	Transmission not received - fault on modem or USART
DATA:CORRUPT	Bit 7 = 1	Data received not same as that transmitted

MAIN TOP LEVEL MENU

An option is selected from a menu by pressing the blue MODE key which is alongside the function shown on the screen. These soft key functions over-ride the normal function of the keys when a menu appears on the screen.

The main top level menu is the menu from which the test modes are selected. See Fig. 3-4. The options are as follows:-

(a) GO/NO-GO TEST. This is a special version of the FULL AUTO TEST mode which provides a quick appraisal of the unit under test. The display format is SUMMARY and the pause is MANUAL ONLY. All other parameters are as specified in FULL AUTO TEST including the test sequence (e.g. COMPREHENSIVE TESTING).

(b) FULL AUTO TEST. This executes a preselected test sequence, either one of the four built-in test sequences or a user-defined test sequence. It is intended for main routine testing. It provides access to the two pages of the **CHANGE FORMAT MENU** which are used to define the test parameters and instrument settings.

(c) MANUAL TEST. This provides the user with a number of individual call processing tests as well as manual control of the data and SAT generators. It would normally be used for trouble shooting and repair work.

(d) SELECT SYSTEM. This option is displayed when the 2960 is fitted with more than one of the system options. It provides access to the **SYSTEM SELECTION MENU**.

Pressing the CRTS key aborts the current test and returns to the main top level menu.

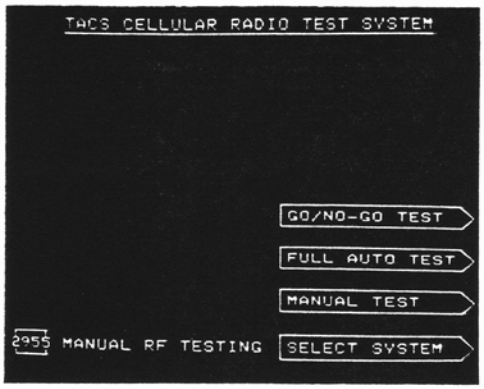


Fig. 3-4 Main top level menu

The 2955 and DISC keys provide the following additional facilities:-

(a) 2955 manual RF testing. Pressing the 2955 key allows the user to manually test the RF and audio stages of a mobile. When the 2955 key is pressed, the 2955's **DUPLEX** test display appears. The display and the test settings are saved as indicated by the LED above the CRTS key. The normal 2955 operating mode can be accessed by pressing the 2955 key a second time.

(b) Disc facility. Pressing the DISC key allows the user to control a disc drive so that test sequences can be stored and retrieved from a floppy disc without the need for an external controller.

SYSTEM SELECTION MENU

This menu allows the user to select which of the system options is to be used. There is a soft key for each of the system options which is fitted. The current system option is shown by an asterisk. See Fig. 3-5.

To change the system, press the appropriate SELECT key twice. Initializing then takes place and the main top level menu is restored, showing the new system. Also, this is then the current system at the next switch-on. Pressing the RETURN soft key restores the main top level menu.

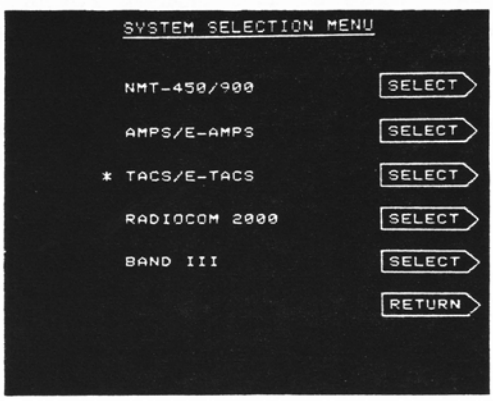


Fig. 3-5 **SYSTEM SELECTION MENU**

FIRST TIME OPERATION

When the instrument is used for the first time, the test settings have to be defined and selected by means of the **CHANGE FORMAT MENU**. To access this menu, first press the FULL AUTO TEST key. The FULL AUTO TEST intermediate display appears as shown in Fig. 3-6. This shows the main test settings currently selected. It also gives the options of CHANGE FORMAT to select the settings or START TEST to commence testing (once the settings have been defined). Press the CHANGE FORMAT key to obtain the **CHANGE FORMAT MENU**.

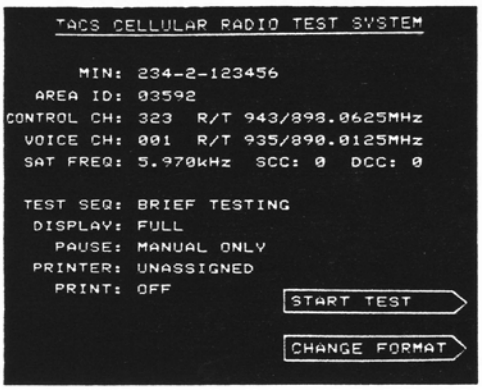


Fig. 3-6 FULL AUTO TEST intermediate display

CHANGE FORMAT MENU

This menu allows the user to define and select test settings before testing is carried out. The current settings are stored in non-volatile memory. This menu is accessed when FULL AUTO TEST is selected from the main top level menu and then CHANGE FORMAT is selected from the FULL AUTO TEST display. The **CHANGE FORMAT MENU** consists of two pages of options to change settings or format display as shown in Fig. 3-7.

Page 1 allows changes to be made under the following options:-

(a) **SYSTEM PARAMETERS MENU**. See page 3-1-10.
(b) **MOBILE PARAMETERS MENU**. See page 3-1-12.
(c) **DISPLAY FORMAT MENU**. See page 3-1-12.
(d) **TEST SEQUENCE MENU**. See page 3-1-14.

Pressing PAGE 2 selects the other page of the menu; RETURN restores the FULL AUTO TEST display.

Page 2 allows changes to be made under the following options:-

(a) **PRINTER MENU**. See page 3-1-15.
(b) **INTERFACE MENU**. See page 3-1-16.
(c) **MISCELLANEOUS MENU**. See page 3-1-17.

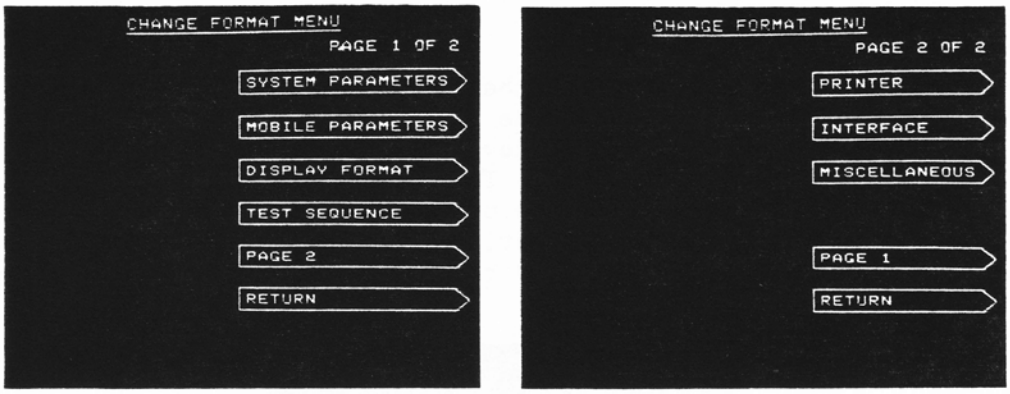


Fig. 3-7 **CHANGE FORMAT MENU** pages 1 and 2

Pressing PAGE 1 selects the other page of the menu; RETURN restores the intermediate menu.

OPTION KEYS

Some of the option keys are marked SELECT and some are marked CHANGE.

A SELECT key has to be pressed repeatedly to scroll through the choices until the required setting is obtained.

A CHANGE key has to be pressed once and then it changes to ENTER. The numerical setting can then be changed by entering a new value on the 2955 keypad. If a mistake is made, press the DELETE key then press the correct key. Any change can be aborted by pressing any other soft key. If the entry is correct, press the ENTER key and then it changes back to CHANGE. If a mistake is now found in the data, the number has to be re-entered after pressing CHANGE.

SYSTEM PARAMETERS MENU

This menu, as shown in Fig. 3-8, allows the user to change parameters under the following options:-

(a) AREA ID.
(b) CONTROL CHANNEL.
(c) VOICE CHANNEL.
(d) HANDOFF INCREMENT.
(e) SAT FREQUENCY.
(f) DCC.

Pressing RETURN restores the **CHANGE FORMAT MENU**.

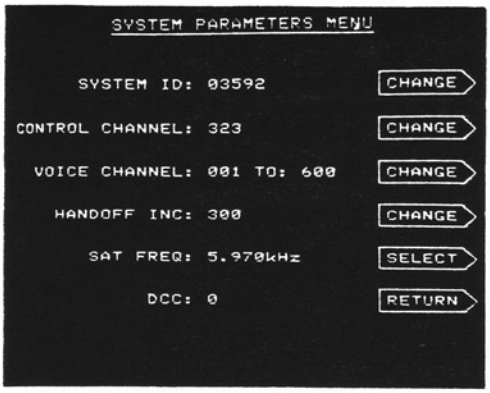


Fig. 3-8 **SYSTEM PARAMETERS MENU**

AREA ID **setting**

Enter a 5-digit decimal number. The default setting is 03592.

CONTROL CHANNEL **setting**

Enter a number in the range 0 to 2047. The default setting is 323.

VOICE CHANNEL **setting**

For the first voice channel and the last voice channel, enter two numbers in the range 0 to 2047. The default settings are 1 and 600.

The first number is for the initial voice channel that the mobile is to be assigned to when it goes into conversation mode. The second number is for the final voice channel that the mobile is to be assigned to in the test sequences and the automatic handoff test routine (no. 24).

HANDOFF INCREMENT **setting**

Enter a number in the range 1 to 2047. The default setting is 300.

This number is for incrementing between the first voice channel and the last during the automatic handoff test routine (no. 24). Usually 3 or 4 channels are tested.

SAT FREQUENCY **selection**

Select a SAT frequency (5.970, 6.000 or 6.030 kHz) to be generated by the mobile when it enters conversation mode. Repeatedly pressing the SAT FREQUENCY soft key shows the different frequencies in turn in reverse. Stop pressing when the required frequency appears. The default selection is 5.970 kHz.

DCC **selection**

For the digital colour code, select 0, 1, 2 or 3. The default selection is 0.

MOBILE PARAMETERS MENU

This menu, as shown in Fig. 3-9, allows a change to be made under the following options:-

(a) MOBILE NUMBER.
(b) CHARGE RATE.

Pressing RETURN restores the **CHANGE FORMAT MENU.**

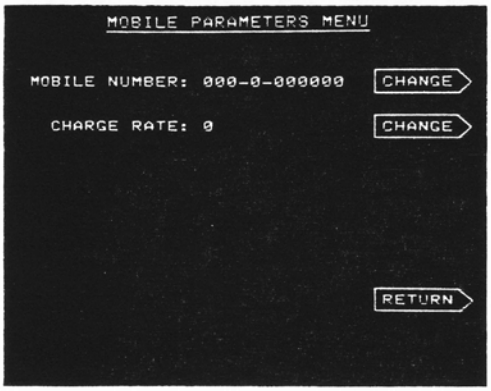


Fig. 3-9 **MOBILE PARAMETERS MENU**

MOBILE NUMBER **setting**

The mobile is identified by a number which has the format XXX-X-XXXXXX. Enter a suitable number. The default setting is 000-0-000000.

CHARGE RATE **setting**

Enter a number in the range 0 to 1023. The default setting is 0.

DISPLAY FORMAT MENU

This menu, as shown in Fig. 3-10, allows selections to be made under the following options:-

(a) DISPLAY FORMAT.
(b) PAUSE.
(c) NUMBER FORMAT.

Pressing RETURN restores the **CHANGE FORMAT MENU.**

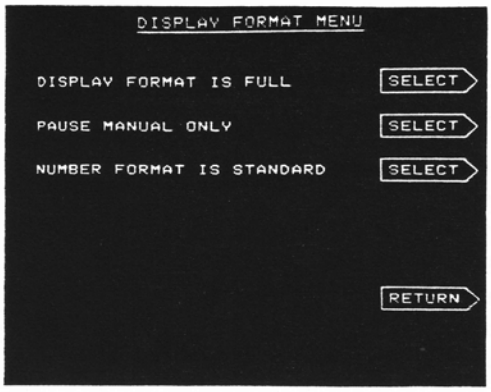


Fig. 3-10 **DISPLAY FORMAT MENU**

DISPLAY FORMAT **selection**

This option selects the display format to be used in the FULL AUTO TEST mode. The choice is between FULL and SUMMARY. FULL format uses a split duplex screen to display the RF and AF parameters of the mobile in the top half with the summary line comprising title, status and result fields together with other information relating to the test routine (e.g. test limits). SUMMARY format shows a scrolling window of up to 10 summary lines with up to the first 9 failures being retained.

Since it is only intended to provide brief information, the GO/NO-GO TEST mode is automatically uses the SUMMARY format.

PAUSE **selection**

This option selects the method of interrupting a test sequence in the FULL AUTO TEST mode from one of the following:-

(a) PAUSE ALWAYS. This causes the test sequence to be halted after each test routine has been completed.

(b) PAUSE MANUAL ONLY. This halts the test sequence only when the PAUSE key is pressed.

(c) PAUSE ON FAILURE. This causes a halt only when a failure has occurred or when the PAUSE key is pressed.

Since it is intended for rapid testing, the GO/NO-GO TEST mode automatically uses PAUSE MANUAL ONLY.

NUMBER FORMAT **selection**

This option selects between HEXADECIMAL, DECIMAL, OCTAL and STANDARD for the mobile's equipment serial number (ESN) which is displayed in the call processing tests. The default setting is STANDARD.

When HEXADECIMAL is selected, the number may subsequently be entered in hexadecimal with the letters A to F being entered by using the SCOPE keys. These are reassigned as a letter keypad and depicted on the screen.

The STANDARD format is as the BABT format.

TEST SEQUENCE MENU

This menu, as shown in Fig. 3-11, allows selection of the test sequence which is used in the GO/NO-GO TEST and the FULL AUTO TEST modes. Selection is made from the following sequences:-

(a) BRIEF TESTING. See page 3-1-31.
(b) COMPREHENSIVE TESTING. See page 3-1-32.
(c) CALL PROCESSING ONLY. See page 3-1-30.
(d) CALL AND RF TESTING. See page 3-1-30.
(e) Title of a user-defined sequence which is held in the 2960's non-volatile user memory. NO SEQUENCE DEFINED is displayed as the default title until it is redefined.

BRIEF TESTING is executed by default.

Also, the menu allows selections to be made under the following options:-

(a) DTMF.
(b) HOOK FLASH.

Pressing RETURN restores the **CHANGE FORMAT MENU**.

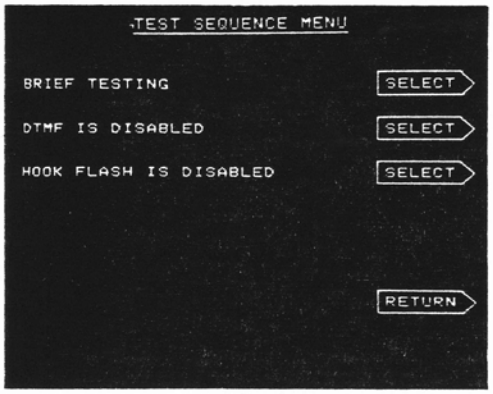


Fig. 3-11 **TEST SEQUENCE MENU**

DTMF selection

For the DTMF tones test routine (no. 30) in test sequences, selection is made between DISABLED and ENABLED. The default setting is DISABLED.

HOOK FLASH selection

For the hook flash test routine (no. 31) in test sequences, selection is made between DISABLED and ENABLED. The default setting is DISABLED.

PRINTER MENU

This menu, as shown in Fig. 3-12, allows selections to be made under the following options:-

(a) PRINTER PORT.
(b) PRINT.
(c) TERMINATE.

Pressing RETURN restores the **CHANGE FORMAT MENU**.

PRINTER PORT **selection**

This option selects which of the three printer ports, GPIB TALK-ONLY, SERIAL RS-232 or PARALLEL, is to be connected to the printer for producing a hard copy of the results in the GO/NO-GO TEST or the FULL AUTO TEST mode. When a printer is not to be used or is not connected, select UNASSIGNED. Otherwise, a PRINTER TIMEOUT error message may be displayed during the test sequence.

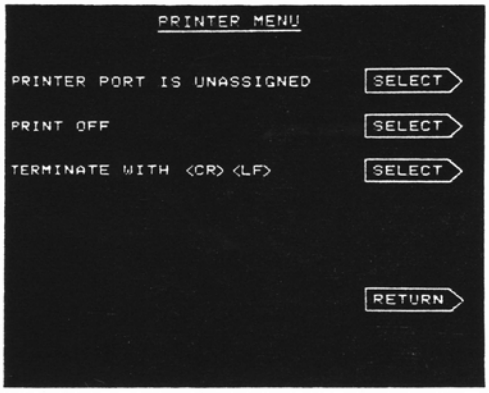


Fig. 3-12 **PRINTER MENU**

PRINT **selection**

This option selects the criteria for printing a test routine and its result as ALL, ON FAILURE or ON PASS. When a printout is not required, select OFF.

TERMINATE **selection**

This option selects the characters which the printer requires to terminate a line. Selections are <CR> and <LF>, <LF> only and <CR> only.

Note...

A printer may be used in 2955 TALK-ONLY mode as follows:-

(1) Connect the printer to the appropriate port and select the parameters from the menus as above.

(2) Switch off both the 2955 and the Adapter.

(3) Set the 2955's GPIB unit to TALK-ONLY (switch 6 to 1) and select the printing mode using switches 1 and 2 as follows:-

Switches 1 and 2	Case	<CR>
00	Upper and lower	Suppressed
01	Upper and Lower	Not suppressed
10	Upper only	Suppressed
11	Upper only	Not suppressed

(4) Switch on both the 2955 and the Adapter then press the HOLD DISPLAY key.

(5) Press PRT to start the printout. Data is now passed from the 2955 through the Adapter to the printer.

(6) When printing is complete, restore the 2955 GPIB unit switch settings to normal.

INTERFACE MENU

This menu, as shown in Fig. 3-13, allows selections to be made under the following options:-

(a) BAUD RATE.
(b) LENGTH/PARITY.
(c) STOP BITS.
(d) GPIB ADDRESS.

Pressing RETURN restores the **CHANGE FORMAT MENU.**

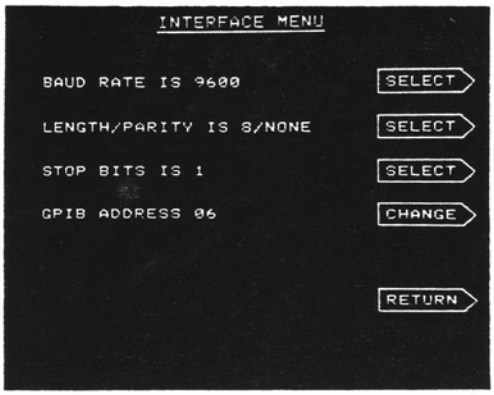


Fig. 3-13 **INTERFACE MENU**

BAUD RATE **selection**

In order to accommodate different types of printers on the RS-232 port, the serial baud rate is selected from 75, 150, 300, 600, 1200, 2400, 4800 and 9600.

LENGTH/PARITY **selection**

Length and parity for the RS-232 port are selected from 7/EVEN, 7/ODD, 7/NONE, 8/EVEN, 8/ODD and 8/NONE.

STOP BITS **selection**

A stop bit or bits is assigned to the end of every byte. This is selected from 1 and 2.

PUBLIC GPIB ADDRESS **selection**

Enter the 2-digit GPIB address using the keypad but do not use 0, 1 or 31. Ensure that TALK ONLY is not selected (i.e. that switch 6 is not set to 0) unless the 2960 is only to be used in the 2955 mode (i.e. for use as a printer port converter).

The 2955's GPIB address is shown at the bottom of the display.

MISCELLANEOUS MENU

This menu, as shown in Fig. 3-14, allows selections to be made under the following options:-

(a) DE-MOD SOURCE.
(b) DISC STEP RATE.
(c) PRINTER PORT COMMAND.

Pressing RETURN restores the **CHANGE FORMAT MENU**.

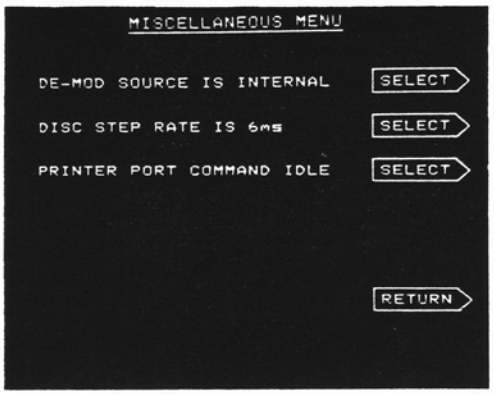


Fig. 3-14 **MISCELLANEOUS MENU**

DE-MOD SOURCE **selection**

This selects the method of demodulating the mobile's transmitted signal as INTERNAL (i.e. through 2960's internal demodulator) or EXTERNAL (i.e. through an external modulation meter). INTERNAL is automatically selected when the 2960 is switched on. The EXTERNAL facility enables the RF section of the mobile to be bypassed so as to test only the modem section.

DISC STEP RATE **selection**

This selects the disc drive head stepping rate to permit a range of drives to be used. Press SELECT repeatedly until the required value appears for the drive in use. The rates are 6, 12, 20 and 30 ms. The selected rate is saved automatically with any file.

PRINTER PORT COMMAND **selection**

This is used when the printer is required to print a specified message. Selection is made from the following:-

(a) IDLE. There is no printer output. This is the default selection.

(b) SEND (flashing). This sends a string (which has been entered under the **EDIT COMMAND MENU**) to the printer. Prior to this, appropriate selections have to be made under the **PRINTER MENU** and the printer has to be enabled. After sending, IDLE is restored.

(c) EDIT (flashing). The **EDIT COMMAND MENU** appears. See below.

EDIT COMMAND MENU

This menu, as shown in Fig. 3-15, allows entry of a message of up to 30 characters to be sent to the printer whenever this is commanded as above. The default message is a <LF>.

To enter or change the message, press the upper CHANGE key. A table of characters appears at the bottom of the display. Select each character of the message by entering first the line number (1 to 3) followed by the column number (0 to 9). Each selected character appears in the PRINTER PORT COMMAND field. Errors can be rectified by using the DELETE key. The message can be aborted at any time by pressing any other soft key. If the message is not required, it can be removed by deleting characters to leave a blank field.

Alternatively or subsequently, press the lower CHANGE key. Hexadecimal digits A to F appear at the bottom of the display to show that the 2955's OSCILLOSCOPE keys are used for these. Select each character of the message by entering its 2-digit hexadecimal code for the 2955's character set as given in its Operating Manual. For numbers and upper-case letters, these are the same as ASCII codes. Terminate the message with 0A (i.e. for <LF>). Each selected character appears in the PRINTER PORT COMMAND field. Codes below hexadecimal 20 (decimal 32) or above hexadecimal 7F (decimal 127) can be entered. Each of these is entered directly or subsequently after leaving a space for it and is shown in the PRINTER PORT COMMAND field as a ?.

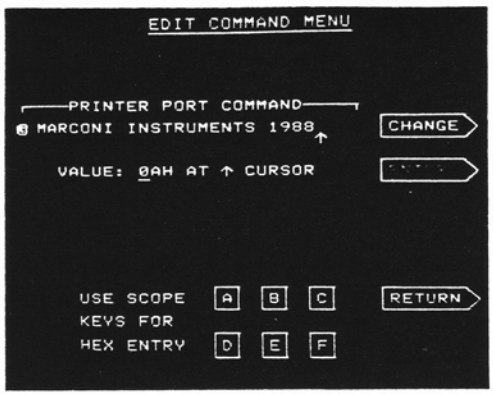


Fig. 3-15 **EDIT COMMAND MENU**

To move the cursor along (or back the the first position after the last), press ENTER.

Pressing RETURN restores the **MISCELLANEOUS MENU**.

PARAMETER STORAGE

Six full sets of parameters can be stored.

From the main top level menu, select FULL AUTO TEST. The FULL AUTO TEST intermediate display appears as shown in Fig. 3-6.

To store the current settings, press the 2955's STORE key followed by one digit from 1 to 6.

To recall settings, press the 2955's RECALL key followed by the same digit which was used to store the setting. The intermediate display is updated accordingly.

When more than one system is being used, settings for one system cannot be recalled into another system. The user has to take note of which store he has used for each set of parameters. This allows the rapid restoration of settings when changing between system options.

GO/NO-GO TEST MODE

This is designed for rapid operation. It executes the test sequence which has been selected from the **CHANGE FORMAT MENU**. It may be one of the four built-in test sequences or an externally-written test sequence which has been loaded into the 2960's memory.

The GO/NO-GO TEST mode is accessed from the main top level menu, as shown in Fig. 3-4, by pressing the GO/NO-GO TEST key. The SUMMARY DISPLAY FORMAT display then appears as shown in Fig. 3-17 and the test sequence is immediately started. The DISPLAY FORMAT is automatically set to SUMMARY irrespective of the current setting in the **DISPLAY FORMAT MENU**.

Results of each test routine are shown but the main purpose of using the GO/NO-GO TEST mode is to make a quick appraisal of the mobile so a PASSED, ERROR: or *FAIL* status is displayed for every test routine. This saves the user's time in interpreting data or checking measurements.

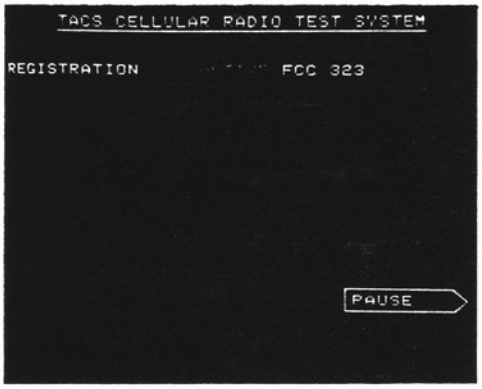


Fig. 3-17 SUMMARY DISPLAY FORMAT display

When printing has been selected from the **PRINTER MENU**, the user can obtain a printout of the test routines and their results using one of the user ports. The format of the printout can be ALL, ON FAILURE or ON PASS depending on the user's selection.

As there may be more than ten test routines in a sequence, scrolling is employed when the screen is full. Failed test routines are collected at the top of the display until the sequence is finished.

In the GO/NO-GO TEST mode, PAUSE is automatically set to MANUAL ONLY irrespective of the current setting in the **DISPLAY FORMAT MENU**. Pressing the PAUSE key causes the sequence to be stopped at the end of the current test routine and the CONTINUE key appears as shown in Fig. 3-20.

At the end of the test sequence, a summary of the test routines and their results is automatically displayed as shown in Fig. 3-19 so that the user can see if the mobile has failed any of the test routines. For test sequences which contain more than ten test routines, failed ones have priority. Pressing the CONTINUE key causes the mobile's MSN and name of country to appear at the bottom of the screen.

Pressing the RETURN key restores the main top level menu.

FULL AUTO TEST MODE

This executes the test sequence which has been selected from the **CHANGE FORMAT MENU**. It may be one of the four built-in test sequences or an externally-written test sequence which has been loaded into the 2960's memory. A split screen display is shown so that the service engineer can monitor the RF and AF parameters.

The FULL AUTO TEST mode is accessed from the main top level menu, as shown in Fig. 3-4, by pressing the FULL AUTO TEST key. The FULL AUTO TEST intermediate display then appears as shown in Fig. 3-6. This shows a summary status of the desired test parameters and display formats held in the non-volatile memory since the **CHANGE FORMAT MENU** was last accessed.

To change any of these, press the CHANGE FORMAT key. See page 3-1-9. To save all the format parameters, six non-volatile stores are available. To store the parameters, press the STORE key followed by a number from 1 to 6. To recall these parameters, press the RECALL key followed by the same number. A printed copy of the results can be also be obtained by using the **CHANGE FORMAT MENU**.

To start the test sequence, press the START TEST key.

When FULL DISPLAY FORMAT has been chosen, the display consists of three sections as shown in Fig. 3-18. Most of the top half is the 2955 DUPLEX display. The bottom half displays the limits for the transceiver test routines plus the mobile's MSN and name of country. Separating the two is the current test routine shown being executed, one test routine at a time.

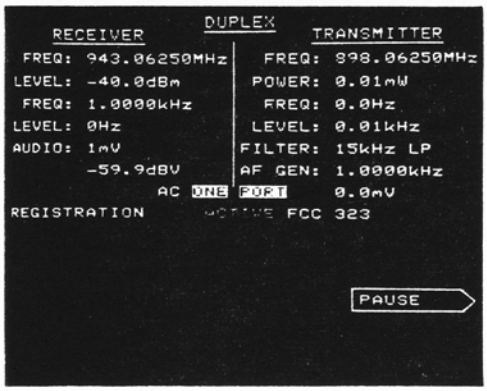


Fig. 3-18 FULL AUTO TEST FULL DISPLAY FORMAT display

When SUMMARY DISPLAY FORMAT has been selected, the display is the same as that for the GO/NO-GO TEST mode as shown in Fig. 3-17. In this case, one line is shown for each test routine so that, as the screen is filled, the lines are scrolled upwards. Failed test routines are collected at the top of the screen.

PAUSE has been previously set to ALWAYS, MANUAL ONLY or ON FAILURE. Pressing the PAUSE key causes the sequence to be interrupted manually at the end of the current test routine. The CONTINUE key appears as shown in Fig. 3-20.

At the end of the test sequence, a summary of the test routines and their results is automatically displayed as shown in Fig. 3-19 so that the user can see which test routines the mobile has failed. For test sequences which contain more than ten test routines, failed ones have priority. Pressing the CONTINUE key causes the mobile's identity to appear at the bottom of the screen.

Pressing the RETURN key restores the FULL AUTO TEST intermediate display.

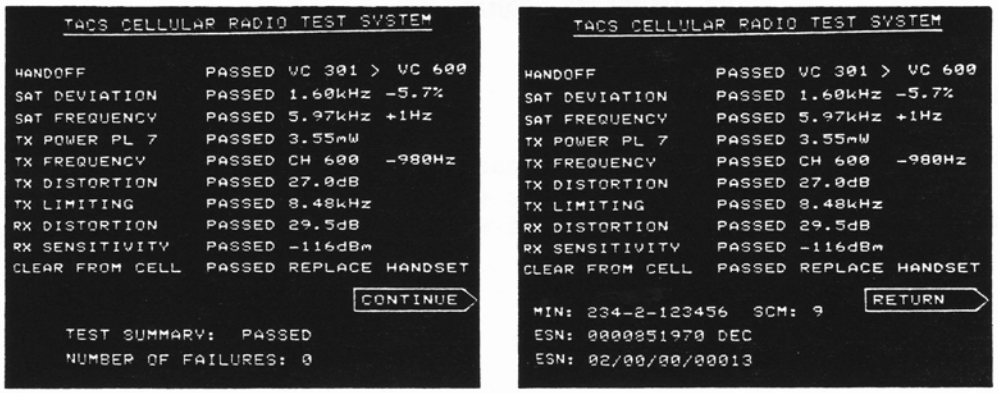

TACS CELLULAR RADIO TEST SYSTEM
HANDOFF PASSED VC 301 > VC 600
SAT DEVIATION PASSED 1.60kHz -5.7%
SAT FREQUENCY PASSED 5.97kHz +1Hz
TX POWER PL 7 PASSED 3.55mW
TX FREQUENCY PASSED CH 600 -980Hz
TX DISTORTION PASSED 27.0dB
TX LIMITING PASSED 8.48kHz
RX DISTORTION PASSED 29.5dB
RX SENSITIVITY PASSED -116dBm
CLEAR FROM CELL PASSED REPLACE HANDSET
CONTINUE
TEST SUMMARY: PASSED
NUMBER OF FAILURES: 0
TACS CELLULAR RADIO TEST SYSTEM
HANDOFF PASSED VC 301 > VC 600
SAT DEVIATION PASSED 1.60kHz -5.7%
SAT FREQUENCY PASSED 5.97kHz +1Hz
TX POWER PL 7 PASSED 3.55mW
TX FREQUENCY PASSED CH 600 -980Hz
TX DISTORTION PASSED 27.0dB
TX LIMITING PASSED 8.48kHz
RX DISTORTION PASSED 29.5dB
RX SENSITIVITY PASSED -116dBm
CLEAR FROM CELL PASSED REPLACE HANDSET
RETURN
MIN: 234-2-123456 SCM: 9
ESN: 0000851970 DEC
ESN: 02/00/00/00013

Fig. 3-19 Test summary displays

TEST SEQUENCE PAUSE

In the GO/NO-GO TEST mode, the test sequence can be interrupted by pressing the PAUSE key. In the FULL AUTO TEST mode, the PAUSE function can be activated manually, automatically after every test routine or when one has failed. This depends on which was selected from the **DISPLAY FORMAT MENU**. In all cases, the test sequence is interrupted only at the end of a test routine. When a PAUSE occurs, the CONTINUE key appears as shown in Fig. 3-20. The user can then select one of the following options:-

(a) CONTINUE.
(b) ABORT TESTING.
(c) MANUAL RF TESTING.
(d) DATA.

CONTINUE option

Pressing the CONTINUE key restarts the test sequence from the point at which it was halted.

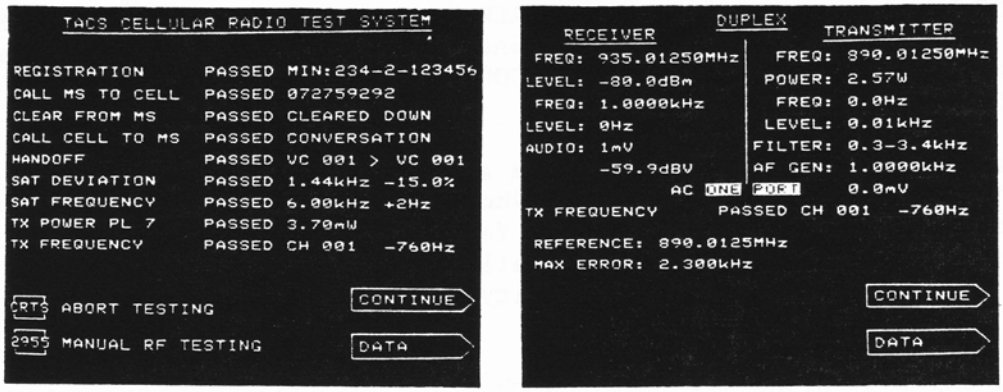


Fig. 3-20 SUMMARY DISPLAY FORMAT and FULL AUTO TEST FULL DISPLAY FORMAT paused displays

ABORT TESTING **option**

To abort the test sequence and access the main top level menu, press the CRTS key. This allows the user to enter the MANUAL TEST facility to carry out specific testing for more detailed fault-finding or to start another test sequence.

MANUAL RF TESTING **option**

When the display shows the 2955 key, the user can press the 2955 key to call up the DUPLEX display which has been automatically set to the parameters of the last test sequence. The user now has manual control of the RF and AF signal generators for alignment and fault finding purposes on the mobile's transceiver circuits. Do not leave DUPLEX operation (i.e. do not press TX or RX) or the mobile will drop out of service. Press the CRTS key to return to the test sequence.

DATA **option**

The data displays allow the user to view the data messages which are sent by the mobile to the cell and from the cell to the mobile during the call processing test routines and in a MANUAL TEST procedure. These displays allow the user to rapidly identify incorrect bits sent by the mobile which may have caused it to fail. They can also serve as an educational or reference facility for users who are unfamiliar with cellular signalling.

Press the DATA key to access the **REVERSE WIDEBAND DATA** display as shown in Fig. 3-21. In the lower half, this shows the 12 hexadecimal digits of the data frames which have been sent by the mobile on the reverse channels during the last signalling test routine. Each word is normally sent five times so the the 2960 can make a majority decision on the contents. If the repeats match the original word, it is shown together with the number of times that it has been sent.

Press the RETURN key to restore the previous display.

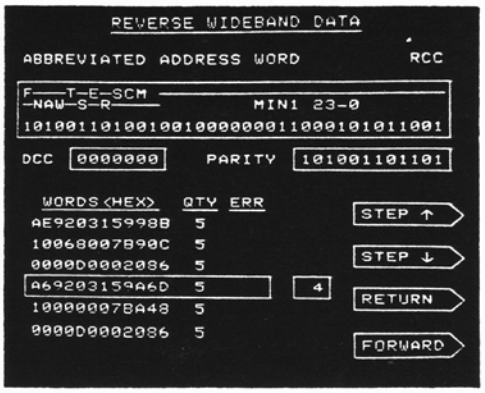


Fig. 3-21 **REVERSE WIDEBAND DATA** display

Press the FORWARD key to access the **FORWARD WIDEBAND DATA** menu as shown in Fig. 3-22. This calls up part of the forward data stream sent by the 2960 which is the most relevant. Selection is from the following options:-

(a) CONTROL FILLER words. These are null data which are sent when no active information is being transmitted. This enables mobiles to scan continuously for a strong signal onto which they can lock.

(b) OVERHEAD MESSAGE words. These contain certain information which relates to the system parameters of the local network (e.g. SID, available control channels).

(c) MOBILE STATION CONTROL FCC words. These contain commands and messages which are sent to a particular mobile on the forward control channel during registration and call set-up. Each word is repeated a number of times to ensure that the mobile receives the correct data.

(c) MOBILE STATION CONTROL FVC words. These contain commands and messages which are sent to a particular mobile on the forward voice channel during a call (i.e. handoff). Each word is repeated a number of times to ensure that the mobile receives the correct data.

The **FORWARD WIDEBAND DATA** display, as shown in Fig. 3-23. In the lower half, this shows the 10 hexadecimal digits of the data frames which have been sent by the 2960 to the mobile during the last signalling test routine. The frame type is shown together with the number of times that the particular frame has been repeated.

Press the REVERSE key to restore the **REVERSE WIDEBAND DATA** display. Press the RETURN key to restore the previous display.

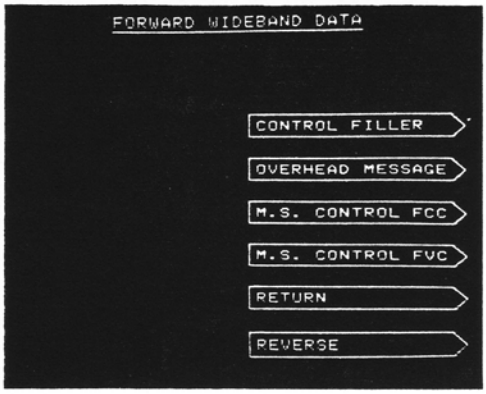


Fig. 3-22 **FORWARD WIDEBAND DATA** menu

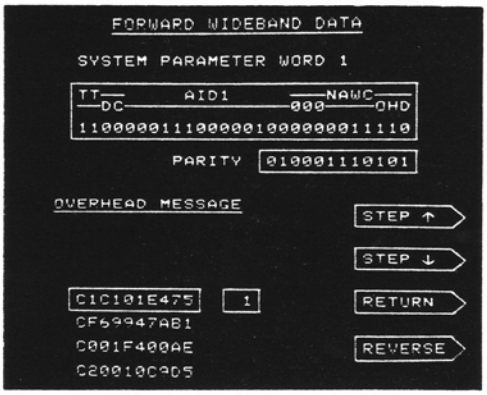


Fig. 3-23 **FORWARD WIDEBAND DATA** display

A frame can be selected for analysis by pressing the STEP ↑ key or the STEP ↓ key until the frame is displayed in the lower box. The frame is then shown as 48 or 40 bits in the box in the upper half together with the frame type in accordance with the TACS specification.

A frame which contains a single incorrect bit is indicated by a C in the ERR column. If more than one bit is incorrect, the frame is indicated by a flashing E. When the frame is shown in the upper box, the incorrect bit(s) are shown in reverse. This helps the user to determine whether the fault is located on the mobile's logic boards or whether the mobile is having problems with the system in which it is working.

To print the data, enable the printer and then press the RX key. The selected frame is then printed in the form of 48 or 40 bits together with the frame type. Repeated pressing of the TX key prints each successive frame.

MANUAL TEST MODE

This provides the user with manual control of the 2960. It is intended to be used for troubleshooting and repair rather than for routine testing.

The MANUAL TEST mode is accessed from the main top level menu, as shown in Fig. 3-4, by pressing the MANUAL TEST key. The **MANUAL OPERATION** display then appears as shown in Fig. 3-24. It consists of a generated section shown on the upper half and a measured section with readings shown on the lower half. Besides scanning the keys and checking the data, the system every second searches for SAT and ST. When these are detected, they are shown in reverse on the display. The received DTMF tones, the supply voltage, current and DC power are also shown. If the voltage remains below 1 V for longer than 6 seconds, the supply voltage, current and power readings are disabled. This enables the SAT readings to be updated three times faster than normal thus making adjustment easier.

The user can access the following options:-

(a) CHANNEL.
(b) SAT FREQ and LEVEL and DATA LEVEL.
(c) MODE.
(d) AF PATH.
(e) DATA.

Pressing the CRTS key restores the main top level menu. Pressing the 2955 key calls up the 2955 **DUPLEX** display. If the CRTS key is pressed once again, the user is taken back to the **MANUAL OPERATION** display.

CHANNEL **setting**

This is selected by pressing the CHANNEL key (which changes to ENTER). The value is then entered on the keypad and terminated with the ENTER key.

This option is normally only used when the user is prompted in the HANDOFF mode. However, it is possible to reverse the 2960's frequency plans by entering a negative number. This means that the MANUAL TEST procedure could be used for testing certain parameters of a base station such as the SAT filters.

SAT FREQ, SAT LEVEL **and** DATA LEVEL **settings**

These are selected by pressing the CHANGE key (which changes to NEXT) and scrolling through to the required setting. Each of the three values is entered on the keypad and terminated with the NEXT key. The default settings of the levels are the TACS specified nominal levels. The SAT frequency is taken from the setting in the **SYSTEM PARAMETERS MENU**. SCC (SAT colour code) value depends upon the frequency setting of the SAT tone.

MODE **selection**

This allows the user to select a signalling test mode depending on the state of the mobile under test. Some of the modes are the same as those in the built-in test sequences; others generate a pattern of data which is primarily intended to test a mobile's modem. In the latter case, the user can access the DATA display by pressing the DATA key to check the mobile's responses. When the user selects a mode, screen prompts are given for the user to enter test parameters.

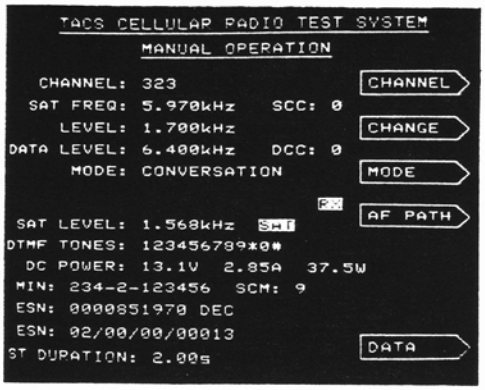


Fig. 3-24 **MANUAL OPERATION** display

To select the mode, press the MODE key (which changes to SELECT). Scroll through the modes available until the required mode appears. The selected mode is implemented after a 2 second timeout.

These modes operate as follows:-

(a) FCC. This sends continuous forward control channels. If the system ID is different from the current setting, the mobile responds with REGISTRATION.

(b) REGISTRATION. This is similar to the corresponding test routine in the built-in sequences. The mobile's MIN, SCM and ESN are displayed together with, provided the mobile registers successfully, the order qualifier OD HEX. The mode then reverts to FCC.

(c) PAGE MOBILE. This is the built-in CALL CELL TO MOBILE test routine. A flashing prompt, together with the mobile's alert signal, requests the user to ANSWER CALL. Upon the user lifting the handset or pressing the SEND key, the mode changes to conversation and the mobile's SAT deviation is displayed.

(d) PLACE CALL. This is the built-in CALL MOBILE TO CELL test routine. A flashing prompt requests the user to PLACE CALL. On the handset, the user keys in up to 32 digits. When they are received by the 2960, they are shown at the bottom of the screen, spill-over digits appearing in the line below. The mode changes to conversation and the mobile's SAT deviation is measured and displayed.

(e) DATA OFF. This switches off the 2960's data generator.

(f) SIGNAL TONE. The 2960's data generator sends a continuous signal tone of 10 kHz.

(g) DOTTING. The 2960 generates the bit synchronization pattern (a series of alternate 1's and 0's) which normally precedes a data message. This mode is used to 'open' the mobile's modem.

When the CALL MOBILE is answered and when the PLACE CALL is successful, there is another level of modes which operate as follows:-

(a) CONVERSATION. In this mode, the user can test the handset's numerical keys. DTMF tones received by the 2960 are shown on the display. The mobile's transmitted SAT level and the DC power consumption are updated every few seconds.

(b) HANDOFF. When this mode is selected, the user is prompted to select a new channel by the flashing cursor and ENTER sign. The new channel number is entered on the keypad and terminated by pressing the ENTER key. The mobile then changes to the new channel and the mode changes to conversation. The duration of the mobile's signal tone is shown at the bottom of the screen.

(c) POWER LEVEL. When this mode is selected, SELECT changes to ENTER and the level (0 to 7) is entered on the keypad. The mobile changes its transmitter power level accordingly and the mode reverts to conversation.

(d) CLEARDOWN. This mode is used to terminate the conversation mode and revert to FCC.

AF PATH **selection**

This is selected by toggling the indicated soft key. It selects which audio signal is routed to the 2955 AF input when 2955 mode is selected and both indicators, CRTS and 2955, are on. The choices are as follows:-

(a) RX. Normal routeing from Adapter AF output to 2955 AF input.

(b) RX X20. Normal routeing from Adapter AF output to 2955 AF input with 26 dB (times 20) amplifier in the path.

(c) TX. The demodulated mobile transmitter signal is fed to the Adapter IF input.

DATA **selection**

Pressing the DATA key accesses the DATA displays.

BUILT-IN TEST SEQUENCES

A number of test routines are combined into built-in test sequences which can be executed in the GO/NO-GO TEST and the FULL AUTO TEST modes. There are four built-in test sequences to choose from as follows:-

(a) CALL PROCESSING ONLY.
(b) CALL AND RF TESTING.
(c) BRIEF TESTING.
(d) COMPREHENSIVE TESTING.

The required sequence is selected from the **TEST SEQUENCE MENU**. See page 3-1-14.

CALL PROCESSING ONLY sequence

This sequence is the basis of all of the built-in test sequences. It consists of a series of data signalling test routines to check the mobile's ability to initiate and receive calls and to respond to system commands. It is intended for first-line testing of radios which have been reported as faulty to retailers and installers. It can also be used for validation testing to determine whether a unit is suitable for sale or installation. The only connection required is from the mobile's antenna socket to the RF IN/OUT N socket on the 2960. The sequence of test routines is as follows:-

(a) REGISTRATION OF MOBILE.
(b) CALL MOBILE TO CELL.
(c) DTMF TONES. Optional.
(d) HOOK FLASH. Optional.
(e) CLEAR DOWN FROM MOBILE.
(f) CALL CELL TO MOBILE.
(g) AUTO HANDOFF.
(h) CLEAR DOWN FROM CELL.

CALL AND RF TESTING sequence

As well as performing the CALL PROCESSING ONLY test routines, this also measures the pertinent RF parameters on all of the channels which have been selected in the **SYSTEM PARAMETERS MENU**. It is intended to be used by workshops for first-line testing. This sequence can also be performed using only the RF connection. The sequence of test routines is as follows:-

(a) REGISTRATION OF MOBILE.
(b) CALL MOBILE TO MTX.
(c) DTMF TONES. Optional.
(d) HOOK FLASH. Optional.
(e) CLEAR DOWN FROM MOBILE.
(f) CALL CELL TO MOBILE.
(g) HANDOFF.
(h) TX RF POWER.
(j) TX RF FREQUENCY.
(k) SAT TRANSPONDING.
(m) CLEAR DOWN FROM CELL.

(g) to (m) are repeated for each selected channel.

BRIEF TESTING **sequence**

This performs some of the standard transceiver test routines in addition to the routines in the CALL AND RF TESTING sequence. It is intended for use by small workshops and regional service centres as their main test facility.

Test routines are performed on three voice channels. The first traffic channel is that selected in the **SYSTEM PARAMETERS MENU**; the second and third are determined by the HANDOFF INCREMENT. It is necessary to connect the audio paths between the mobile and the handset to the test system for this sequence as well as from the mobile's antenna to the RF IN/OUT N socket. The sequence of test routines is as follows:-

(a) REGISTRATION OF MOBILE.
(b) CALL MOBILE TO CELL.
(c) DTMF TONES. Optional.
(d) HOOK FLASH. Optional.
(e) CLEAR DOWN FROM MOBILE.
(f) CALL CELL TO MOBILE.
(g) HANDOFF.
(h) SAT TRANSPONDING.
(j) TX RF POWER.
(k) TX RF FREQUENCY.
(m) TX AF DISTORTION (SINAD).
(n) TX MODULATION LIMITING.
(p) RX AF DISTORTION (SINAD).
(q) RX SENSITIVITY.
(r) CLEAR DOWN FROM CELL.

(g) to (r) are repeated for three channels.

COMPREHENSIVE TESTING **sequence**

This is intended for major service centres and manufacturers who wish to test more of the mobile's operational aspects. All of the connections which are shown in Fig. 3-1 are required for this test sequence. The sequence of test routines is as follows:-

(a) REGISTRATION OF MOBILE.
(b) CALL MOBILE TO CELL.
(c) DTMF TONES. Optional.
(d) HOOK FLASH. Optional.
(e) CLEAR DOWN FROM MOBILE.
(f) CALL CELL TO MOBILE.
(g) AUTO HANDOFF.
(h) BIT ERROR RATE.
(j) HANDOFF.
(k) SAT TRANSPONDING.
(m) TX RF POWER.
(n) DC POWER.
(p) TX RF FREQUENCY.
(q) TX AF DISTORTION (SINAD).
(r) TX MODULATION LIMITING.
(s) TX MODULATION COMPRESSION.
(t) RX AF DISTORTION (SINAD).
(u) RX SENSITIVITY.
(v) RX DEMODULATION EXPANSION.
(w) CLEAR DOWN FROM CELL.

(j) to (w) are repeated for each selected channel.

NON-SYSTEM SPECIFIC TEST ROUTINES

The test routines which are not specific to the TACS system are described below together with any applicable error messages and their meanings. When performing transmitter test routines (no. 1 to no. 5), the 2960 automatically adjusts the audio generator output level in order to excite the mobile at the required nominal deviation. If it cannot get a settled reading of this deviation, the test routine is failed and READING UNSTABLE is reported in the result field. This is normally due to one of the two following causes:-

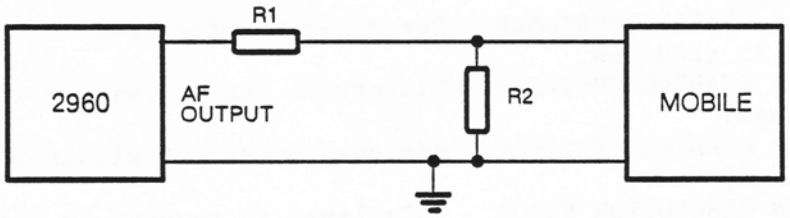
(a) The microphone in the mobile under test is still live and ambient noise is causing the reading to be unstable. This situation should be avoided as it degrades an otherwise good SINAD or distortion measurement.

(b) The corresponding audio generator level is such that the setting resolution is greater than the tolerance of deviation being set (e.g. at 9 mV, with steps of 1mV, gives a setting resolution of 11% which is greater than the acceptance tolerance of ±5%). To rectify this, an attenuator should be inserted to bring the required level above 10 mV.

When performing transmitter limiting test routines, the audio generator output level is adjusted to obtain the nominal deviation. The output level is then increased by an overload factor of 20 dB. If this new level exceeds the maximum output level of the audio generator (2.5 V), then the test routine is failed and the message LOW SENS MIC I/P is displayed. Normally, 250 mV is sufficient to excite a mobile. A low output level could be due to a mismatch, typically a balanced input. In this case, a balun transformer could be used to balance the output of the 2960 and also provide voltage gain.

The effective dynamic range of the audio generator output is 20 log (2.5 V / 10mV) = 48 dB. As the required dynamic range is 20 dB, the ideal value for the output level is 10 mV + 14 dB = 50 mV.

Assuming that the mobile has an input impedance of greater than 1 KΩ, see Fig. 3-25 for suitable resistance values to obtain approximate attenuations.



Attenuation	R1	R2
3 dB	33Ω	68Ω
6 dB	50Ω	50Ω
10 dB	68Ω	33Ω
20 dB	91Ω	10Ω

Fig. 3-25 AF generator output attenuator

Test routine no. 1 - Transmitter RF power (TX POWER)

Measures the RF power. This is not used in the standard test sequences since the CALL AND RF TESTING, BRIEF TESTING and COMPREHENSIVE TESTING sequences use the system specific power test routine which sets the mobile to the required power levels before measuring. Messages are as follows:-

(a) *FAIL* NO TX POWER. Power <1 mW. Probably there is no carrier so a very low power level is not displayed.
(b) *FAIL* READING UNSTABLE. After 15 attempts, could not obtain two consecutive readings within 20%.

Test routine no. 2 - Transmitter RF frequency (TX FREQUENCY)

First ensures that a carrier is present and then auto-tunes to measure the RF frequency. For cellular radios, then manually retunes to the correct channel. Messages are as follows:-

(a) *FAIL* NO TX POWER. Power <1 mW. Assumes there is no carrier so cannot take meaningful frequency measurement.
(b) *FAIL* READING UNSTABLE. Frequency not within 1% after 15 readings.

Test routine no. 3 - Transmitter AF distortion (TX DISTORTION), transmitter SINAD (TX SINAD), transmitter S/N (TX S/N) and transmitter residual noise (TX NOISE)

Attempts to set the AF level to produce a reference modulation level (but not for the residual noise test routine). Routes the 2960 demodulated signal to the AF INPUT of the 2955 and tests audio as for receiver distortion and SINAD. S/N is measured by reading the demodulated level with and without a modulating signal. Residual noise measurement is deviation of the carrier in the absence of a modulating signal. Messages are as follows:-

(a) *FAIL* LOW DEMOD LEVEL. 2960 internal demodulated level <100 mV either due to 2960 fault or reference modulation level is too low to produce 100 mV demodulated.
(b) *FAIL* READING UNSTABLE. Demodulated level not within 10% after 15 readings.
(c) *FAIL* READING UNSTABLE. Demodulated noise level not within 100% after 15 readings.
(d) *FAIL* READING UNSTABLE. Distortion etc not within 20% after 5 readings.
(e) *FAIL* READING UNSTABLE. Residual noise not within 50% after 10 readings.
(f) AF GEN RESOLUTION ERROR. (Displayed in reverse at the bottom of the screen). Audio generator output level is below 10 mV. This means that, with steps of 1 mV, it may not be possible to set the required deviation to within ±5%.

Test routine no. 4 - Transmitter modulation limiting (TX limiting)

Attempts to set an AF level to produce a reference modulation level, then increases the AF level by the overload factor and measures the resulting deviation in a 15 kHz bandwidth (including de-emphasized SAT). Messages are as follows:-

(a) *FAIL* LOW SENS MIC I/P. AF level required to set the transmitter to reference modulation level was too high to overload by the factor given. (Generator maximum output is 2.5 V.)
(b) *FAIL* NO MODULATION. Deviation <100 Hz/1%/0.1 rad measured.
(c) *FAIL* READING UNSTABLE. Deviation not within 10% after 5 readings.

Test routine no. 5 - Transmitter modulation compression (TX COMPRESSION).

Attempts to set an AF level to produce a reference modulation level, then alters the AF level by +10 dB and -10 dB. Measurement is resulting change in modulation level. Result is (20 dB) / (modulation level change in dB). Messages are as follows:-

(a) *FAIL* LOW DEMOD LEVEL. Demodulated level is below 100 mV. (Demodulated level is reference level + compressed 10 dB change.)
(b) *FAIL* LOW DEMOD LEVEL. Demodulated level is below 10 mV. (Demodulated level is reference level - compressed dB change.)
(c) *FAIL* READING UNSTABLE. Demodulated level not within 10% after 15 readings.
(d) *FAIL* NO MODULATION. ±10 dB change in AF generator output produced <1 dB change in transmitter modulation.
(e) *FAIL* LOW SENS MIC I/P. Cannot modulate to reference level +10 dB (i.e. >2.5 V).
(f) AF GEN RESOLUTION ERROR. (Displayed in reverse at the bottom of the screen). Audio generator output level is below 10 mV. This means that, with steps of 1 mV, it is not possible to set the required deviation to within ±5%.

Note...

When conducting receiver tests, it is necessary to have a recovered audio signal level of >5 mV, corresponding to the required deviation (i.e. 8.0 kHz). Otherwise, the SINAD/distortion measurement may not be accurate. If the recovered level is below 50 mV, then either a fault exists in the interface circuit or there is a gross mismatch. Where there is a balanced output, this may be rectified by using a balun transformer or the Marconi Instruments 600 Ω accessory.

Test routine no. 6 - Receiver distortion (RX DISTORTION), receiver SINAD (RX SINAD) and receiver S/N (RX S/N)

Sets modulation level directly and measures distortion, SINAD and S/N directly from 2955. 2960 AF IN (mobile's receiver audio) is routed to the 2955 AF IN. Messages are as follows:-

(a) *FAIL* LOW DEMOD LEVEL. Receiver audio level <5 mV.
(b) *FAIL* READING UNSTABLE. Distortion etc not within 20% after 5 readings.
(c) AF GEN RESOLUTION ERROR. (Displayed in reverse at the bottom of the screen). Audio generator output level is below 10 mV. This means that, with steps of 1 mV, it may not be possible to set the required deviation to within ±5%.

Test routine no. 7 - Receiver sensitivity (RX SENSITIVITY)

Attempts to adjust the receiver level until the mobile's receiver audio produces the reference SINAD reading required. Result is the RF level. Messages are as follows:-

(a) *FAIL* LOW DEMOD LEVEL. Receiver audio level <5 mV.
(b) *FAIL* NO DEMODULATION. Reached receiver level limit at -95 dBm or -122 dBm without reaching reference SINAD level.
(c) *FAIL* READING UNSTABLE. SINAD not within 20% after 5 readings and 10 iterations of setting level.

Test routine no. 8 - Receiver demodulation expansion (RX EXPANSION)

Sets receiver modulation level directly to reference level -5 dB and +5 dB. Measurement is resulting change in receiver audio level in dB. Result is (audio level change in dB) / (10 dB).

(a) *FAIL* LOW DEMOD LEVEL. Demodulation level <5 mV (reference level -5 dB).
(b) *FAIL* LOW DEMOD LEVEL. Demodulation level <5 mV (reference level +5 dB).
(c) *FAIL* READING INSTABLE. Demodulation not within 10% after 15 readings.
(d) ERROR: MODULATION LIMIT. Cannot modulate to reference level +5 dB.

Test routine no. 9 - DC power consumption (DC POWER)

Routes voltages corresponding to DCV/25 and DCA/10 to 2955; measures DC voltages and calculates power. Messages are as follows:-

(a) *FAIL* NO DC POWER. <250 mV or <100 mA or <100 mW.
(b) *FAIL* READING UNSTABLE. Not within 10% after 15 readings.

Test routines no. 10 to no. 19

Not implemented.

SYSTEM SPECIFIC TEST ROUTINES

The test routines which are specific to the TACS system are described below together with any applicable error messages and their meanings.

Test routine no. 20 - Registration of mobile on control channel (REGISTRATION)

This test routine checks the mobile's ability to register on the system. Operation is as follows:-

(1) The test routine title is displayed and the 2960 initializes the data generation system as a control channel.

(2) The 2960 generates an FCC for the mobile to lock onto. The FCC number is shown on the display.

(3) If the mobile cannot lock onto the control channel, the 2960 tries again in other systems (independent provider or local company). The message *FAIL* NO RESPONSE means that there is no response or CRTS is aborted.

(4) The mobile locks onto the FCC and sends registration updating messages with the MIN, ESN and SCM.

(5) The 2960 checks the received data and displays the MIN and PASSED for a good test. Failure messages are as follows:-

(a) *FAIL* DATA INCOMPLETE. Not all of the message was received.
(b) *FAIL* DATA CORRUPT. The message was corrupted.
(c) *FAIL* DATA CORRECTED. A bit error has been corrected.
(d) *FAIL* DATA IGNORED. There were insufficient correct repetitions.
(e) *FAIL* TOO MANY WORDS. The message was longer than the format.
(f) *FAIL* WRONG RESPONSE. The response was wrong for the message which was sent.

Test routine no. 21 - Call placement from cell to mobile (CALL CELL TO MOBILE)

This test routine checks the mobile's ability to answer an incoming call. The number called is the currently stored MIN. Operation is as follows:-

(1) The test routine title is displayed.

(2) The 2960 generates an FCC for the mobile to lock onto. PAGING MS is displayed and the mobile is paged every 2 seconds. The message *FAIL* NO RESPONSE means that no response was received within 30 seconds.

(3) The mobile locks onto the FCC and responds with data.

(4) The 2960 checks the received data. Failure messages are as follows:-

(a) *FAIL* DATA INCOMPLETE. Not all of the message was received.
(b) *FAIL* DATA CORRUPT. The message was corrupted.
(c) *FAIL* DATA CORRECTED. A bit error has been corrected.
(d) *FAIL* DATA IGNORED. There were insufficient correct repetitions.
(e) *FAIL* TOO MANY WORDS. The message was longer than the format.
(f) *FAIL* WRONG RESPONSE. The response was wrong for the message which was sent.

(5) The 2960 checks the SCM. The message ERROR: ONLY 2047 CHANNEL means that a channel greater than this was attempted.

(6) The 2960 assigns and displays the first voice channel (e.g. VC ASSIGN CH 001).

(7) The mobile tunes to the voice channel.

(8) The 2960 checks for the carrier and displays CARRIER ON or the message *FAIL* NO CARRIER. The failure message means that there was no carrier >100 mW within 5 seconds.

(9) The 2960 sends the alerting order and switches on the SAT.

(10) The mobile responds by switching on the signalling tone.

(11) The 2960 checks for the signalling tone. The message *FAIL* NO SIGNALLING TONE means that no signalling tone was received within 5 seconds.

(12) The mobile rings and ANSWER CALL flashes on the display.

(13) The user either picks up the handset or presses the SEND key, depending upon the audio connections. The signalling tone stops and CONVERSATION appears on the display together with PASSED for a successful test.

Test routine no. 22 - Call placement from mobile to cell (CALL MOBILE TO CELL)

This checks the mobile's ability to place a call. Operation is as follows:-

(1) The test routine title is displayed together with WAIT FOR SERVICE.

(2) After 2 seconds, WAIT FOR SERVICE is replaced by PLACE CALL flashing.

(3) The 2960 waits for a response. The message *FAIL* NO RESPONSE means that no response was received within 30 seconds.

(4) The user keys a number (up to 32 digits, only 16 being shown in a summary display) into the handset and presses the SEND key. The mobile sends the MIN, the ESN and the called number.

(5) The 2960 checks the received data. Messages are as follows:-

(a) *FAIL* DATA INCOMPLETE. Not all of the message was received.
(b) *FAIL* DATA CORRUPT. The message was corrupted.
(c) *FAIL* DATA CORRECTED. A bit error has been corrected.
(d) *FAIL* DATA IGNORED. There were insufficient correct repetitions.
(e) *FAIL* TOO MANY WORDS. The message was longer than the format.
(f) *FAIL* WRONG RESPONSE. The response was wrong for the message which was sent.

(6) The 2960 checks the SCM. The message ERROR: ONLY 2047 CHANNEL means that a channel greater than this was attempted.

(7) The 2960 assigns and displays the first voice channel (e.g. VC ASSIGN CH 001).

(8) The mobile tunes to the voice channel.

(9) The 2960 checks for the carrier and displays CARRIER ON or the message *FAIL* NO CARRIER. The failure message means that there was no carrier >100 mW within 5 seconds.

(10) The 2960 switches on the SAT and displays the dialled number with PASSED or the message *FAIL* NO CARRIER. The failure message means that no carrier is present.

(11) If GHARGE RATE has been selected under the **MOBILE PARAMETERS MENU**, CHARGE RATE ACK is displayed together with PASSED for a successful test. The message *FAIL* NO RESPONSE means that no response was received within 500 ms.

Test routine no. 23 - Handoff from current to chosen traffic channel (HANDOFF)

This checks the mobile's ability to retune to another voice channel (which has been selected by the user under the **CHANGE FORMAT MENU**) while in conversation mode (e.g. from channel 001 to 600 by an increment of 300). Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) The 2960 checks the SCM. The message ERROR: ONLY 2047 CHANNEL means that a channel greater than this was attempted.

(3) The 2960 assigns and displays the first voice channel (e.g. VC ASSIGN CH 001).

(4) The 2960 waits for signalling tone confirmation. The message *FAIL* NO SIGNAL TONE means that no ST was received within 3 seconds.

(5) The mobile sends the signalling tone.

(6) The 2960 waits for the mobile's carrier on the new channel. The message *FAIL* NO CARRIER means that a carrier >100 mW was not received within 5 seconds.

(7) The mobile tunes to the new voice channel.

(8) The 2960 confirms successful handoff (e.g. CH 001 >CH301).

(9) The 2960 checks the signalling tone duration and displays PASSED for a good test. The message *FAIL* SIGNAL TONE DURATION means that the duration was not 50 ms ±5 ms or ±10%.

Test routine no. 24 - Automatic handoffs from first to last traffic channel (AUTO HANDOFF)

This test routine is based on no. 23. However, the mobile steps from the first channel by the channel increment until the last channel is reached or exceeded (from channel 001 to 600 by increments of 200). Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) The 2960 checks the SCM. The message ERROR: ONLY 2047 CHANNEL means that a channel greater than this was attempted.

(3) The 2960 assigns and displays the first voice channel (e.g. VC ASSIGN CH 001).

(4) The 2960 waits for signalling tone confirmation. The message *FAIL* NO SIGNAL TONE means that no ST was received within 3 seconds.

(5) The mobile sends the signalling tone.

(6) The 2960 waits for the mobile's carrier on the new channel. The message *FAIL* NO CARRIER means that a carrier >100 mW was not received within 5 seconds.

(7) The mobile tunes to the new voice channel.

(8) The 2960 confirms successful handoff (e.g. CH 001 >CH201).

(9) The handoff is repeated for channels 401 and 600.

(10) The 2960 checks the signalling tone duration and displays PASSED for a good test. The message *FAIL* SIGNAL TONE DURATION means that the duration was not 50 ms ±5 ms or ±10%.

Test routine no. 25 - SAT transponding (TRANSPONDED SAT)

This test routine measures the SAT frequency and deviation. Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) The 2960 tests SAT for transponding and SAT DETECTED is displayed. The message *FAIL* NO SAT DETECTED means that the SAT was not detected.

(3) If required, the SAT deviation is checked. SAT DEVIATION is displayed.

(4) The 2960 takes an average of 8 measurements and PASSED is displayed for a good test. The message *FAIL* READING UNSTABLE means that the measurements are <100 mV or differ by >2%.

(5) If required, the SAT frequency is checked. SAT FREQUENCY is displayed.

(6) The 2960 takes an average of 8 measurements and PASSED is displayed for a good test. The message *FAIL* READING UNSTABLE means that the measurements are <1.000 kHz or differ by >1%.

Test routine no. 26 - Clearing down from cell (CLEAR FROM CELL)

This test routine is the final one in all four built-in test sequences. It is similar to no. 27 except that it checks whether the mobile can acknowledge a call termination by the other party. Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) ORDER RELEASE is displayed and the 2960 sends the clearing order and waits for the signalling tone. The message *FAIL* NO SIGNAL TONE means that no ST was received within 30 seconds.

(3) The mobile sends the signalling tone.

(4) When the ST is received, SIGNAL TONE is displayed. When the ST ends, CLEARED DOWN is displayed.

(5) The 2960 checks the signalling tone duration and PASSED is displayed for a good test. The message *FAIL* SIGNAL TONE DURATION means that the ST duration was not 1.8 s ±50 ms or ±10%.

Test routine no. 27 - Clearing down from mobile (CLEAR FROM MOBILE)

This test routine checks the mobile's ability to terminate the call which it has made in the previous test. Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) END CALL flashes and the 2960 waits for the signalling tone. The message *FAIL* NO SIGNAL TONE means that no ST was receieved within 20 seconds.

(3) The user replaces the handset or presses the END key.

(4) The mobile sends the signalling tone.

(5) When the ST is received, SIGNAL TONE is displayed. When the ST ends, CLEARED DOWN is displayed.

(6) The 2960 checks the signalling tone duration and PASSED is displayed for a good test. The message *FAIL* SIGNAL TONE DURATION means that the ST duration was not 1.8 s ±50 ms or ±10%.

Test routine no. 28 - Mobile transmitter RF power (MOBILE TX POWER)

This test routine checks up to all eight of the mobile's RF power levels. Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR:NO VOICE CHANNEL means that the previous call placement has failed.

(2) The 2960 instructs the mobile to set a power level and then waits for a response. The power level number appears on the display. The message *FAIL* NO RESPONSE means that no response was received within 700 ms.

(3) The mobile acknowledges and then sets the power level.

(4) The 2960 decodes the response. Messages are as follows:-

(a) *FAIL* DATA INCOMPLETE. Not all of the message was received.
(b) *FAIL* DATA CORRUPT. The message was corrupted.
(c) *FAIL* DATA CORRECTED. A bit error has been corrected.
(d) *FAIL* DATA IGNORED. There were insufficient correct repetitions.
(e) *FAIL* TOO MANY WORDS. The message was longer than the format.
(f) *FAIL* WRONG RESPONSE. The response was wrong for the message which was sent.

(5) The 2960 takes an average of 4 measurements of the mobile's power level with reference to its SCM. The message *FAIL* READING UNSTABLE means that the measurements are <1 mW or differ by >2%.

(6) If required, the 2960 instructs the mobile to reset the power level and then takes another measurement.

(7) PASSED is displayed for a good test. The message *FAIL* x.xxW means that the power level is outside limits.

Test routine no. 29 - Bit error rate (DATA PERFORMANCE)

This test routine checks the accuracy of the mobile's data reception under low level conditions. Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) The 2960 checks the RF generator level parameter. Messages are as follows:-

(a) ERROR: PARAMETER RANGE. The level was outside the parameter range.
(b) ERROR: PARAMETER UNITS. The level was not in dBm.

(3) The 2960 sets the RF generator level and then checks the bit error rate lower limit parameter. Messages are as follows:-

(a) ERROR: PARAMETER RANGE. The level was outside the parameter range.
(b) ERROR: PARAMETER UNITS. The level was not in % units.

(4) The 2960 sends an audit order to the mobile and waits for a confirmation message.

(5) The 2960 waits for the SAT to be transponded. The message *FAIL* SAT DROPOUT means that no SAT was detected within 3 seconds.

(6) The 2960 checks for response and logs success.

(7) The 2960 checks 10 times for any response. If no response is received, the test is aborted. Otherwise, the test repeats from (4) another 99 times. The message *FAIL* NO RESPONSE means that there was no response after 10 tests.

(8) After 100 successful tests, PASSED is displayed together with the % bit error rate. The message *FAIL* xxx% means that the percentage pass was outside the limit.

Test routine no. 30 - DTMF tones (DTMF TONES)

This test routine checks the mobile's ability to generate DTMF tones at the correct frequency. This is optional and has to be enabled or disabled under the **TEST SEQUENCE MENU**. Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) The 2960 checks that this test routine is enabled. The message ERROR: NOT ENABLED means that it is not.

(3) WAITING FOR TONES is displayed and the 2960 waits for the tones. The message *FAIL* NO RESPONSE means that no tones were received within the time limit.

(4) On the handset, the user presses the number, * and # keys. This transmits tone pairs with each key press. These can be heard when the volume is turned up.

(5) The data symbols are displayed (i.e. 1 2 3 4 5 6 7 8 9 0 * #) for confirmation sequentially as they are received.

(6) The user checks the symbols for accuracy and then presses CONTINUE. This causes PASSED to appear on the display.

Test routine no. 31 - Hook flash (HOOK FLASH)

This test routine checks the mobile's ability to send a hook flash signalling tone of the correct duration and interrogates the mobile for the hook flash data. This is optional and has to be enabled or disabled under the **TEST SEQUENCE MENU**. Operation is as follows:-

(1) The test routine title is displayed and the 2960 tests for conversation mode. The message ERROR: NO VOICE CHANNEL means that the previous call placement has failed.

(2) The 2960 checks that this test routine is enabled. The message ERROR: NOT ENABLED means that it is not.

(3) The 2960 requests the user to send flash and waits for the signalling tone. The message *FAIL* NO RESPONSE means that there was no ST within 20 seconds.

(4) On the handset, the user enters numerical data and then presses the SEND key. A signalling tone is transmitted. This can be heard when the volume is turned up.

(5) The 2960 receives the tone and instructs the mobile to send the called address.

(6) The called address is displayed for confirmation. Messages are as follows:-

(a) *FAIL* DATA INCOMPLETE. Not all of the message was received.
(b) *FAIL* DATA CORRUPT. The message was corrupted.
(c) *FAIL* DATA CORRECTED. A bit error has been corrected.
(d) *FAIL* DATA IGNORED. There were insufficient correct repetitions.
(e) *FAIL* TOO MANY WORDS. The message was longer than the format.
(f) *FAIL* WRONG RESPONSE. The response was wrong for the message which was sent.

(7) The 2960 checks the signalling tone duration and PASSED is displayed for a good test. The message *FAIL* SIGNAL TONE DURATION means that the ST duration was not 400 ms ±50 ms or ±10%.

Test routine no. 32 - Data deviation (DATA DEVIATION)

This test routine is used to measure the mobile's data deviation while in conversation. A reference level of 6.4 kHz is used with a maximum error which has a default value of 10%. The maximum error parameter can be specified in % or Hz. This is checked for valid units and range. Operation is as follows:-

(1) Upon initialization, the test routine title is displayed and a check is made to ensure that the mobile is in conversation. If not, the message NO VOICE CHANNEL is displayed and the test routine is terminated.

(2) The maximum error parameter is checked to see that it has the correct units and is within the correct range (0 to 100% or 0 to 6.4 kHz). If not, the message PARAMETER UNITS or PARAMETER RANGE is displayed and the test routine is terminated.

(3) The 2960 sends an audit order to the mobile. The deviation of the mobile's response is then measured. If there is no response from the mobile, the message NO RESPONSE is displayed and the test routine is terminated.

(4) Provided the measurement was successful, the result is displayed and the test routine is passed if it is within the specified limits. If the measurement was not successful, the message BELOW THRESHOLD or READING UNSTABLE is displayed. Possible messages are as follows:-

(a) PASSED x.xxkHz ±xxxHz.
(b) PASSED x.xxkHz ±xx%.
(c) ERROR: PARAMETER UNITS.
(d) ERROR: PARAMETER RANGE.
(e) *FAIL* NO RESPONSE.
(f) *FAIL* BELOW THRESHOLD.
(g) *FAIL* READING UNSTABLE.
(h) *FAIL* x.xxkHz ±xxxHz.
(j) *FAIL* x.xxkHz ±xx%.

Test routine no. 33 - Signalling tone deviation (ST DEVIATION)

This test routine is used to measure the mobile's signalling deviation. To obtain a valid result, it has to follow a test routine no. 21 because the deviation is measured and stored while the mobile is ringing in the test routine no. 21. A reference level of 6.4 kHz is used with a maximum error which has a default value of 10%. The maximum error parameter can be specified in % or Hz. This is checked for valid units and range. Operation is as follows:-

(1) Upon initialization, the test routine title is displayed.

(2) The maximum error parameter is checked to see that it has the correct units and is within the correct range (0 to 100% or 0 to 6.4 kHz). If not, the message PARAMETER UNITS or PARAMETER RANGE is displayed and the test routine is terminated.

(3) A check is made to see that a valid ST deviation reading has been taken. If not, the message NO READING is displayed and the test routine is terminated.

(4) Provided the measurement was successful, the result is displayed and the test routine is passed if it is within the specified limits. Possible messages are as follows:-

(a) PASSED x.xxkHz ±xxxHz.
(b) PASSED x.xxkHz ±xx%.
(c) ERROR: PARAMETER UNITS.
(d) ERROR: PARAMETER RANGE.
(e) *FAIL* NO READING.
(f) *FAIL* x.xxkHz ±xxxHz.
(g) *FAIL* x.xxkHz ±xx%.

Test routine no. 34 - Signalling tone duration (ST DURATION)

This test routine is used to measure the duration of the mobile's signalling tone. To obtain a valid result, it has to follow a test routine no. 23, 24, 26, 27 or 31 because the ST duration is measured and stored during these test routines. The reference duration is dependent on the test routine as follows:-

Test routine no.	Test type	Reference duration
23	Handoff	50 ms
24	Automatic handoff	50 ms
26	Clear from cell	1.8 s
27	Clear from mobile	1.8 s
31	Hook flash	400 ms

A maximum error is used. In all cases, it has a default value of 10%. The maximum error parameter can be specified in % or Hz. This is checked for valid units and range. Operation is as follows:-

(1) Upon initialization. the test routine title is displayed.

(2) The maximum error parameter is checked to see that it has the correct units and is within the correct range (0 to 100% or 0 to 10 s. If not, the message PARAMETER UNITS or PARAMETER RANGE is displayed and the test routine is terminated.

(3) A check is made to ensure that a valid ST duration reading has been taken. If not, the message NO READING is displayed and the test routine is terminated.

(4) Provided the measurement was successful, the result is displayed and the test routine is passed if it is within the specified limits. Possible messages are as follows:-

(a) PASSED xx.xs ±x.xs.
(b) PASSED xx.xs ±xx%.
(c) ERROR: PARAMETER UNITS.
(d) ERROR: PARAMETER RANGE.
(e) *FAIL* NO READING.
(f) *FAIL* xx.xs ±x.xs.
(g) *FAIL* xx.xs ±xx%.

Test routines no. 35 to no. 39

Not implemented.

2960 Supplement 30

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